The Tropical Agriculturist.

The Agricultural Journal of Ceylon.

Founded 1881

Published by

The Department of Agriculture,

Peradeniya.

Vol. LXXVI

Containing Numbers 1 to 6,

January to June, 1931.

PRINTERS:—CAVE COLOMBO.

INDEX

Volume LXXVI, January-June, 1931

Number	Month	Pages
1	January	1- 64
2	February	65-132
3	March	133-196
4	April	197-260
5	May	261-326
6	June	327-392

Page

A.

Agriculture, Systems of Agriculture and the Position of Tropical - 288
Alternative Green Manure Plants - 135
Analyses of Leguminous Green Manures, Further - 334
An Economic View of Rubber Planting - 320
Animal Disease Return 63, 130, 194, 259, 325, 390
Ants, Water-and-oil treatment against soil-inhabiting Termites and - 236
Assam, Malaria Problem of - 303

B.

Beetle, Preconceived Notions and the Coconut - 197
Bengal, Cinchona Industry in - 137
Blanketing on the Plasticity of Crepe, Effect of - 274
Board of Agriculture, Minutes of Meeting of the - 115
Botanic Gardens, National - 284
British Guiana, Coconut Cultivation in - 171
Budding in the Field at Peradeniya - 4
Burning Qualities of Tobacco, Recent Experiments on the - 360

C.

Cacaó, Manurial Experiments with - 263
Canker of Citrus, Spraying against - 337
Cause of Variability in the Plasticity of Plantation Rubber after Storage - 342
Ceylon, Mango in - 199
Ceylon, Preliminary Report on the trade in and cultivation of Spice Crops in - 212
Ceylon's Spice Trade - 65
Chemical Notes (10) - 334
Chemical Research on Paddy Soils in the Madras Presidency, Story of two decades of - 227
Cinchona Industry in Bengal - 137
Citrus, Spraying against Canker of - 337
Clones, Identifying Hevea - 358

Page

C.—*Contd.*

Clove Industry in Zanzibar - 364
Coconut Beetle, Preconceived Notions and the - 197
Coconut Cultivation in British Guiana - 171
Coconut Research Scheme (Ceylon), Minutes of Meeting of the Board of Management of the - 52
Coconut Statistics of Malaya for 1924 and 1930 - 242
Coffee Cultivation in Java - 238
Coffee Cultivation, Some Factors in - 299
Commission on Paddy Cultivation, Minutes of Meeting of the - 252
Committee on Soil Erosion, Report of the - 261
Comparison of Methods of Preparing Plantation Rubber in Ceylon, Malaya, and Java - 18
Copra, Factors of Quàlity in - 292
Crepe, Effect of Blanketing on the Plasticity of - 274
Cultivation of Spice Crops in Ceylon, Preliminary Report on the trade in and - 212
Curing of Tobacco, Flue - 100
Cypripedium insigne Wall. (Lady's slipper orchid or shoe of Venus) - 3

D.

Data on the Latex Tube Bore in Rubber, New - 276
Departmental Notes 54, 126, 255, 382
Diameter of the Latex Tubes and the Rubber Production of ***Hevea brasiliensis,*** Investigation into the relation between the - 146
Disease Return, Animal 63, 130, 194, 259, 325, 390
Diseases of Rubber in Ceylon in 1930 - 270
Draft Minutes of Meeting of the Board of Management of the Rubber Research Scheme (Ceylon) - 100

INDEX.—*Contd.*

Page

E.

Editorial 1, 65, 133, 197, 261, 327
Effect of Blanketing on the Plasticity of Crepe - 274
Effect of Interval between the *Morning and Evening* Milking on the Quantity and Quality of Milk - 180
Effect of Maturation on the Plasticity of Smoked Sheet - 345
Empire Insects, Home for - 113
Empire Spices - 232
Estate Products Committee of the Board of Agriculture, Minutes of Meeting of the - 244
Experiment, Irrigation Pot - 329
Experiment Station Peradeniya, Progress Report of the 54, 126, 255, 380
Experiments on the Burning Qualities of Tobacco, Recent - 360
Experiments with Cacao, Manurial - 263
Extraordinary General Meeting of the Rubber Research Scheme (Ceylon) - 378

F.

Factors in Coffee Cultivation, Some - 299
Factors of Quality in Copra - 292
Feedstuff, Rubber Seed-cake as a - 170
Fertilisers, Home mixing of - 108
Flue-curing of Tobacco - 100
Food Products Committee of the Board of Agriculture, *Minutes* of Meeting of the - 308
Food Supply, Nitrogen Industry and Our - 35
Foreign Trade of the United States of America in Tea in 1930 - 240
Fruit Growing, Rootstock Influence in - 223
Fruit Industry for the Gold Coast 1, 27
Further Analyses of Leguminous Green Manures - 334

G.

Gardens, National Botanic - 284
General Meeting of the Rubber Research Scheme (Ceylon), Extraordinary - 378
Gold Coast, Fruit Industry for the 1, 27
Gonakele Estate, Report on Sulphur Dusting Experiments at - 13
Green Manure Plants, Alternative - 135
Green Manures, Further Analyses of Leguminous - 334

H.

Hevea brasiliensis, Investigation into the relation between the Diameter of Latex Tubes and the Rubber Production of - 146
Hevea Clones, Identifying - 358
Hevea, Manurial Experiments on 42, 94
Home for Empire Insects - 113
Home Mixing of Fertilisers - 108

Page

I.

Identifying Hevea Clones - 358
Industry for the Gold Coast, Fruit 1, 27
Insects, Home for Empire - 113
Interesting Rubber Figures - 187
Investigation into the Relation between the Diameter of the Latex Tubes and the Rubber Production of *Hevea brasiliensis* - 146
Irrigation Pot Experiment - 329
Italy, Rice Cultivation in - 218

J.

Java, Coffee Cultivation in - 238

L.

Labour Problems of Ceylon - 324
Lady's Slipper Orchid or Shoe of Venus (*Cypripedium insigne* Wall) - 3
Latex Tube Bore in Rubber, New Data on the - 276
Latex Tube Bore Theory - 215
Latex Tubes and the Rubber Production of *Hevea brasiliensis*, Investigation into the Relation between the Diameter of - 146
Leguminous Green Manures, Further Analyses of - 334

M.

Madras Presidency, Story of two decades of Chemical Research on Paddy Soils in the - 227
Maha Paddy, Note on the Effect of Sowing date on the age of - 332
Malaria Problem of Assam - 303
Malaya for 1924 and 1930, Coconut Statistics of - 242
Mango in Ceylon - 199
Manure Plants, Alternative Green - 135
Manures, Further Analyses of Leguminous Green - 334
Manurial Experiments on Hevea 42, 94
Manurial Experiments with Cacao - 263
Manurial Experiments with Rice —Part III - 70
Manuring under Slump Conditions, Tea - 340
Maturation on the Plasticity of Smoked Sheet, Effect of - 345
Meeting of the Board of Agriculture, Minutes of - 115
Meeting of the Board of Management of the Coconut Research Scheme (Ceylon), Minutes of - 52
Meeting of the Board of Management of the Rubber Research Scheme (Ceylon), Minutes of 188, 373
Meeting of the Board of the Tea Research Institute of Ceylon, Minutes of 120, 250, 380
Meeting of the Commission on Paddy Cultivation, Minutes of - 252
Meeting of the Estate Products Committee of the Board of Agriculture, Minutes of - 244

INDEX.—*Contd.*

Page

M.—*Contd.*

Meeting of the Food Products Committee of the Board of Agriculture, Minutes of - 308
Meeting of the Rubber Research Scheme (Ceylon), Extraordinary General - 378
Meteorological Report 64, 131, 195, 260, 326, 391
Methods of Preparing Plantation Rubber in Ceylon, Malaya and Java, Comparison of - 18
Milk, Effect of Interval between the Morning and Evening Milking on the Quality and Quantity of - 180
Milking on the Quality and Quantity of Milk, Effect of Interval between Morning and Evening - 180
Minutes of Meeting of the Board of Agriculture - 115
Minutes of Meeting of the Board of Management of the Coconut Research Scheme (Ceylon) - 52
Minutes of Meeting of the Board of the Tea Research Institute of Ceylon 120, 250
Minutes of Meeting of the Board of Management of the Rubber Research Scheme (Ceylon) 188, 373
Minutes of Meeting of the Commission on Paddy Cultivation - 252
Minutes of Meeting of the Estate Products Committee of the Board of Agriculture - 244
Minutes of Meeting of the Food Products Committee of the Board of Agriculture - 308
Mound-building Termites, Note on the Destruction of the Nests of - 67

N.

National Botanic Gardens - 284
New Data on the Latex Tube Bore in Rubber - 276
Nitrogen Industry and our Food Supply - 35
Note on the Destruction of the Nests of Mound-building Termites - 67
Note on the Effect of Sowing date on the Age of Maha Paddy - 332
Notes (10), Chemical - 334
Notes, Departmental 54, 126, 255
Notes of Interest - 186
Notes (IV), Paddy - 329
Notions and the Coconut Beetle, Preconceived - 197

O.

Oil, Production of Whale - 106
Oil Treatment against Soil-inhabiting Termites and Ants, Water and - 286
Orchid (*Stanhopea ecornuta* Lem.) - 269
Orchid or Shoe of Venus, Lady's Slipper (*Cyprepedium insigne* Wall) - 8

Page

P.

Paddies, Viability of long-aged - 329
Paddy Commission and the Price of Rice - 327
Paddy Cultivation, Minutes of Meeting of the Commission on - 252
√Paddy Soils in the Madras Presidency, Story of two decades of Chemical Research on - 227
Paddy Notes (IV) - 329
Peradeniya, Progress Report of the Experiment Station 54, 126, 255, 380
Plantation Rubber after Storage, Cause of Variability in the Plasticity of - 342
Plantation Rubber in Ceylon, Malaya and Java, Comparison of Methods of Preparing - 18
Plants, Alternative Green Manure - 135
Plasticity of Crepe, Effect of Blanketing on the - 274
Plasticity of Plantation Rubber after Storage, Cause of Variability in the - 342
Plasticity of Smoked Sheet, Effect of Maturation on the - 345
Position of Tropical Agriculture, Systems of Agriculture and the - 288
Pot Experiment, Irrigation - 329
Preconceived Notions and the Coconut Beetle - 197
Preliminary Report on the Trade and Cultivation of Spice Crops in Ceylon - 212
Price of Rice, Paddy Commission and the - 327
Production of Whale Oil - 106
Progress Report of the Experiment Station, Peradeniya 54, 126, 255, 380

Q.

Quality in Copra, Factors of - 292
Quinine - 133

R.

Recent Experiments on the Burning Qualities of Tobacco - 360
Relation between the Diameter of the Latex Tubes and the Rubber Production of *Hevea brasiliensis,* Investigation into the - 146
Report in connection with Visit to the East (Comparison of Methods of Preparing Plantation Rubber in Ceylon, Malaya and Java) - 18
Report, Meteorological 64, 131, 195, 260, 326, 391
Report of the Committee on Soil Erosion - 261
Report on Sulphur Dusting Experiments on Gonakele Estate - 13
Report on the Trade in and Cultivation of Spice Crops in Ceylon, Preliminary - 212
Research Work on Rubber Cultivation in 1929 - 84

INDEX.—*Contd.*

Page

R.—*Contd.*

Research Work on Rubber Cultivation in 1929 (Continued) - 350
Return, Animal Disease 63, 130, 194, 259, 325, 390
Reviews - 314
Rice Cultivation in Italy - 218
Rice, Paddy Commission and the Price of - 327
Rice—Part III, Manurial Experiments with - 70
Rootstock Influence in Fruit Growing - 223
Rubber after Storage, Causes of Variability in the Plasticity of Plantation - 342
Rubber Cultivation in 1929, Research Work on - 84
Rubber Cultivation in 1929 (Continued), Research Work on - 350
Rubber Figures, Interesting - 187
Rubber in Ceylon 1930, Diseases of - 270
Rubber in Ceylon, Malaya, and Java, Comparison of Methods of Preparing Plantation - 18
Rubber, New Data on the Latex Tube Bore in - 276
Rubber Production of *Hevea brasiliensis*, Investigation into the Relation between the Diameter of the Latex Tubes and the - 146
Rubber Seed-cake as a Feedstuff - 170
Rubber Research Scheme (Ceylon), Extraordinary General Meeting of the - 378
Rubber Research Scheme (Ceylon), Draft Minutes of Meeting of the Board of Management of the - 188
Rubber Research Scheme (Ceylon), Minutes of Meeting of the Board of Management of the - 373
Rubber, Smoke-house for - 47
Rubber Supplies, World's - 143
Rutherford's Planters' Note Book - 317

S.

Seed-cake as a Feedstuff, Rubber - 170
Shoe of Venus, Lady's Slipper Orchid (*Cypripedium insigne* Wall) or - 3
Slump Conditions, Tea Manuring under - 340
Smoke-house for Rubber ("Devon" type) - 47
Smoked Sheet, Effect of Maturation on the Plasticity of - 345
Soil Erosion in Ceylon - 314
Soil Erosion, Report of the Committee on - 261
Soil-inhabiting Termites and Ants, Water and Oil Treatment against - 236
Soils in the Madras Presidency, Story of two decades of Chemical Research on Paddy - 227
Some Factors in Coffee Cultivation - 299

S.—*Contd.*

Sowing date of the age of Maha Paddy, Note on the Effect of - 332
Spice Crops in Ceylon, Preliminary Report on the Trade in and Cultivation of - 212
Spices, Empire - 232
Spice Trade, Ceylon's - 65
Spraying against Canker of Citrus - 337
Stanhopea ecornuta Lem. - 269
Statistics of Malaya for 1924 and 1930, Coconut - 242
Storage, Cause of Variability in the Plasticity of Plantation Rubber after - 342
Story of two decades of Chemical Research on Paddy Soils in the Madras Presidency - 227
Sulphur Dusting Experiments at Gonakele Estate, Report on - 13
Systems of Agriculture and the Position of Tropical Agriculture - 288

T.

Tea - 186
Tea Growing in Nyasaland - 186
Tea in 1930, Foreign Trade of the United States of America in - 240
Tea Manuring under Slump Conditions - 340
Tea Research Institute of Ceylon, Minutes of Meeting of the Board of the 120, 150, 380
Termites and Ants, Water-and-oil Treatment against Soil-inhabiting - 236
Termites, Note on the destruction of the Nests of Mound-building - 67
Tobacco, Flue-curing of - 100
Tobacco, Recent Experiments on the Burning Qualities of - 360
Trade in and Cutivation of Spice Crops in Ceylon, Preliminary Report on the - 212
Trade of the United States of America in Tea in 1930, Foreign - 240
Tropical Agriculture, Systems of Agriculture and the Position of - 288
Tube Bore in Rubber, New Data on the Latex - 276
Tube Bore Theory, Latex - 215
Tung Oil Production in Florida - 187

V.

Variability in the Plasticity of Plantation Rubber after Storage, Cause of - 342
Viability of long-aged Paddies - 329
Visit to the East, Report in connection with (Comparison of Methods of Preparing Plantation Rubber in Ceylon, Malaya, and Java) - 18

W.

Water-and-Oil Treatment against Soil-inhabiting Termites and Ants - 236
Whale Oil, Production of - 106
World's Rubber Supplies - 143

INDEX.—*Contd.*

ILLUSTRATIONS APPEARING IN Nos. 1-6 of Vol. LXXVI

	Page
Cypredium insigne Wall.	- 3
Effect of Sowing date on age of a Maha Paddy—Fig. II	- 333
Nitrogen Cycle in the United Kingdom	- 37
Nitrogen Production	- 36
Stanhopea ecornuta Lem.	- 269
Temperature of Exposure—Fig. I (Cause of Variability in the Plasticity of Plantation Rubber after Storage)	- 344
Viability of Long-aged Paddy Seed—Fig. I	- 332

The

Tropical Agriculturist

January 1931

EDITORIAL

A FRUIT INDUSTRY FOR THE GOLD COAST

SOUTH African fruit experts have recently been seriously discussing the possibility of disposing of large quantities of oranges and grape fruits on the markets of India and Ceylon. One member of the South African fruit industry expresses himself certain that India and Ceylon can take all the oranges that South Africa is able to produce. It is a very anomalous position that India produces and could produce to an enormously increased extent the finest flavoured oranges obtainable anywhere in the world. These are the loose skinned "Santara" of Central India, an orange of most attractive appearance and flavour. Owing to its peculiar loose skin, for when ripe the fruit inside can almost be shaken free from the rind without opening the latter, this orange does not travel well for long distances. The brother of a recent distinguished Viceroy, a commercial man of eminence, tried to convey this orange to Europe feeling sure of its commercial possibilities there but was unable to do so in a marketable condition. It would be quite possible however with a little organisation to put this fruit profitably and in enormous quantity and good condition upon the markets in the Indian towns so that no South African fruit could compete with it. The organisation is at present what is lacking. Besides the "Santara" India produces many other good oranges. The dryness of the atmosphere in India is a great asset in the production of colour and flavour in the orange. The atmospheric humidity on the other hand is the cause of the frequently permanent green skin and lack of flavour in the oranges produced in most parts of Ceylon. Whilst the grape

fruit does not flourish well in India many regions in Ceylon are peculiarly suited to certain good varieties of this fruit. The best oranges of Central India are produced where the annual rainfall is some 45 inches. Grape fruit prefers a higher rainfall, not less than 50 inches, a condition found in Ceylon. If a market for grape fruit exists in India it ought to be possible for Ceylon to develop it rather than South Africa. A good market too for Ceylon grape fruit might be found with the boats that put into Colombo. Californian or other grape fruit that is put upon the boats in England has reached the time when replenishment with fresh fruit in Colombo would certainly be entertained if a good local fruit were obtainable. Australian and Far Eastern boats both on the outward and homeward voyage could advantageously replenish at Colombo. There should be our own home market in the Island itself for the fruit, whilst markets further away, including perhaps even Southern Europe, might be possible fields. A canning industry too might not be forgotten. Several varieties of grape fruit have been proved as suitable for cultivation in Ceylon, Marsh's Seedless grafted upon lime or sour orange stock has demonstrated itself as a satisfactory kind. Seedling trees are generally not worth growing. We print in this number an extract from a paper upon a Fruit Industry for the Gold Coast read by Mr. G. H. Eady of the Department of Agriculture, Gold Coast, before the Second Conference of West African Agricultural Officers which contains much up-to-date information upon grape fruit and lemons. It is prefixed by his remarks upon the Gold Coast climate which show it in some respects to approximate to that of Ceylon.

Cypripedium insigne Wall.

CYPRIPEDIUM INSIGNE

LADY'S SLIPPER ORCHID OR SHOE OF VENUS

K. J. ALEX. SYLVA, F.R.H.S.,
ACTING CURATOR,
HAKGALA BOTANIC GARDENS

Cypripedium insigne Wall. of the Himalayas, belongs to a race of handsome terrestrial orchids found widely distributed in both hemispheres. The plant has branching fibrous roots and a short stem bearing a cluster of leaves clasping it at the base. The flowers are very peculiar with two large brown-mottled or streaked sepals and a pair of narrow petals in the midst of which projects a slipper-like pouch or bag with inturned edge (the labellum).

On account of its easy culture, beautiful foliage, and flowers, the genus *Cypripedium* is well worthy of a position in the green-house. The foliage of several species of the genus is beautifully mottled and make the plants very handsome ornamental specimens even when out of bloom.

Cypripediums being terrestrial, with a few exceptions, do well in a compost made up of the following:

1 part turfy soil
1 ,, leaf mould
½ ,, finely broken limestone or (coarse sand)
½ ,, well-decomposed cattle manure.

It is not necessary that perforated pots should be used for potting Cypripediums as for most epiphytic orchids, but it is very important that the drainage should be good as these are very susceptible to the effects of bad drainage which causes damping off of the foliage. The pot should at least for one-fourth of its depth be arranged with clean broken crocks, over which a few dry leaves or *Sphagnum* moss should be placed to prevent the drainage being choked by the soil.

When potting the plant, care should be taken to see that the roots are well spread over the soil and that the base of the stem is about an inch below the rim of the pot. This space may be filled with a layer of *Sphagnum* moss so as to maintain the plant in moist condition during the early stage of growth. After potting, the plants need watering sparingly during the first few weeks till the fresh growth appears. When the plant is in active growth more water will be necessary.

Propagation could readily be effected by the division of the plant. A good well-established plant is capable of as many as half a dozen divisions but it would not be advisable to make such divisions too small so as to consist of only single plants as these will be too weak to obtain a healthy start in life. Cypripediums are more or less suited to the higher altitudes of Ceylon but with a little care and attention they can be cultivaed to perfection even at lower elevations.

BUDDING IN THE FIELD AT PERADENIYA

T. H. HOLLAND, DIP. AGRIC. (WYE).
MANAGER, EXPERIMENT STATION, PERADENIYA

THE STATE OF GROWTH OF THE STOCK

THE quarterly journal of the Rubber Research Institute of Malaya, Vol. 1, Nos. 1 and 2, contains an article by C. E. T. Mann entitled *Budding in the Field*. The author examines the effects of various factors on the percentage of successes obtained.

Mann's figures show that the highest percentage of successes was obtained in the group of stocks which were in a state of vigorous growth both at budding and at the time of opening the binding, while the lowest percentage was obtained in the group of stocks which were dormant at both these times. The latter figure (40%) is considerably lower than the percentage obtained in the next best class, but the differences between the other classes are not striking *e.g.* 72% successes were obtained with stocks that were dormant at budding but vigorous at opening against 73% with stocks that were vigorous on both occasions, while 63% successes were obtained with stocks that were vigorous at budding but dormant at opening.

Naturally the periods of activity and dormancy will not exactly synchronise in any large number of stocks and when budding starts the stocks will be at all stages, varying from full activity to complete dormancy.

It must now be considered to what practical use any conclusions drawn from Mann's investigation of this particular factor can be put. It is fairly easy to say which plants are in a state of active growth at any one time but it is thought to be hardly practicable to judge at the time of budding which stocks are likely to remain in a state of activity throughout the period between budding and opening. Even if this were possible, to select for budding only those stocks which are just entering on a period of vigorous growth would entail a large number of rounds of budding and a great expenditure of time and labour, and this procedure hardly apppears to be a practical proposition for large scale field work. Even to bud at one time only plants in a state of active growth would entail certainly three rounds of budding and would complicate affairs and add considerably to the expense.

During July, August, and September 1930, clones of 26 Ceylon mother trees were established for testing purposes on the Iriyagama Division of the Experiment Station, Peradeniya. These clones were divided among three areas in each of which plots of Heneratgoda No. 2 tree appear as a standard of comparison, while in area 3 plots of mixed seedlings are also included. Areas 1 and 2 thus each contain 9 clones + H2, while area 3 contains 8 clones + H2 and seedlings. The budding for area 2 was all done on one-year-old seedling stocks in the nursery, while in areas 1 and 3 budding was done in the field, additional nursery stocks being budded to fill vacancies and to replace failures. Area 1 was planted in 1928 with two-year-old stumps. Vacancies for which additional stumps were not available were filled with 1928 and 1929 seedlings. It will thus be seen that the stocks in this area show considerable variation. Area 3 was planted in the north-east monsoon of 1928 with 1928 seedling basket plants. The growth of stocks in this area is considerably more vigorous and more even than that of the stocks in area 1.

During the budding in areas 1 and 3 the state of growth of each stock at the time of budding was recorded. The state of the stocks at the time of the first and second inspections was also recorded, but for reasons given above the latter records are not included in this account.

The results in areas 1 and 3 are given in tables 1 and 2.

Table I

Results of budding in the field on stumps planted in 1928 or seedling supplies planted in 1928 or 1929 in area 1 of the Iriyagama Division.

Clone	Number of stocks budded	Percentage success on stocks growing vigorously	Percentage success on dormant stocks	Percentage success on all stocks
Wawulugala 120	60	86·6	80·0	85·0
H 2	56	65·4	76·7	71·4
Nakiadeniya 10	59	92·5	79·00	88·1
Eladuwa 1	57	61·0	61·9	61·4
Yogama 21 Y	59	86·3	93·3	88·1
Govinna 1836	58	60·0	58·1	58·6
Mirishena 2	60	40·0	50·0	45·0
Mirishena 11	56	23·5	13·6	19·4
H 411	59	47·6	52·6	50·8
Cuilcagh 5	59	80·0	85·2	83·0
Total	583	—	—	—
Average	58	64·3	65·3	65·0

Table II

Results of budding in the field on 1928 seedlings planted out as basket plants in October-November, 1928, in area 3 of the Iriyagama Division.

Clone	Number of stocks budded	Percentage success on stocks growing vigorously	Percentage success on dormant stocks	Percentage success on all stocks
H 2	101	59·6	34·7	47·5
H 401	108	96·0	91·3	93·5
H 439	106	85·9	92·8	88·6
Hillcroft 34	109	74·3	74·3	74·3
Milleniya 162	111	59·0	64·4	61·2
Udapola 24	102	65·6	73·7	68·6
H 47	108	56·7	50·0	52·8
H 203	100	87·7	74·5	83·0
H 24	110	60·5	61·7	60·9
Total	955	—	—	—
Average	106	71·7	68·6	70·0

It will be seen that in area 1 in six clones higher percentages were obtained on stocks that were dormant at the time of budding while in four clones the reverse was the case. The difference between the average percentages in the two classes of stocks is negligible.

In area 3 higher percentages were obtained on dormant stocks in four clones, in four clones higher percentages were obtained on active stocks, while in the remaining clone the percentages were identical. Again the difference between the average percentages can be considered to be negligible.

It would appear, therefore, from this record that for estate practice the question of whether each individual stock is active or dormant at the time when it is desired to start budding is not worth considering, though it might be desirable to start budding when the majority of the stocks were beginning to show active growth, if such a period could be determined.

WEATHER CONDITIONS

Mann examined this factor and compared results from budding in (1) showery weather, and (2) drought conditions. His figures show that little difference was found at the first opening of the buddings for examination but that the percentage of final successes was considerably greater when the budding had been done during showery weather.

Statements have sometimes been made as to the importance of the actual climatic conditions at the time of budding and it may be as well to examine this point first.

Budding is not usually attempted on wet days and apart from fine distinctions as to the differences in mean temperature humidity, degree of sunlight, etc., of which data are not available in the present instance, budding days can be roughly divided into sunny and dull days. Table 3 gives the results from such a procedure.

Table III

Results of Budding under different weather conditions

Clone	Weather conditions on day of budding	Percentage success	
Area 1			
H 411	Dull	50·8	Average 49·5
Cuilcagh 5	Dull	83·0	
Mirishena 2	Dull	45·0	
Mirishena 11	Dull	19·4	
H 2	Dull morning, hot sunny afternoon		71·4
Nakiadeniya 10	Sunny and very hot	88·1	Average 76·2
Eladuwa 1	Sunny and dry	61·4	
Wawulugala 20	Sunny and dry	85·0	
Govinna 1368	Sunny and dry	58·6	
Yogama 21y	Sunny and dry	88·1	
Area 3			
Udapola 24	Dull and sultry	68·6	Average 70·8
H 203	Dull	83·0	
H 24	Dull and drizzling	60·9	
H 2	Dull morning, hot and sunny afternoon		47·5
H 401	Sunny and very hot	93·5	Average 74·1
H 439	Sunny and very hot	88·6	
Milleniya 162	Sunny and dry	61·[illegible]	
Hillcroft 34	Sunny and dry	74·3	
H 47	Sunny and dry	52·6	

It must be stated that in a few cases on hot days budding was stopped between 10 a.m. and 3 p.m. while in other cases budding was continued all day.

It has usually been presumed that dull cool weather is preferable for budding but the above record does not appear to support this, in fact in both areas the largest percentages of successes were obtained in clones which were budded on sunny days especially noted as being very hot.

It may be argued that the weather on the day of budding is of comparatively small importance compared with the general climatic conditions during the month following budding. This may be so, but unfortunately few planters will be able to predict these conditions with certainty, and few in Ceylon have the ready means of obtaining frequent long range meteorological forecasts. The question of rainfall is probably more important and will be separately considered, but it may be concluded from the figures given that there is no reason why budding in the field should not be done on hot sunny days and that if the climatic conditions on the day of budding have any effect at all it is probably masked by the more potent factors such as the personal factor, the condition of the budwood, and the individuality of the clone.

An attempt will now be made to study the influence of rainfall for a short period before and after budding. Mann found that appreciably better results were obtained in showery weather than under "drought conditions."

In the present instance none of the budding was done in weather that could be described as "drought conditions." In table 4 the rainfall for 5 days before budding and 10 days after budding is shown and the clones are divided into two classes: in each area the clones above the line were budded during periods of more frequent and heavier rain than those below the line. The former appeared to have gained no advantage however, in fact the highest percentages of success are found in the periods of least rainfall. It may well be, however, that the difference between the conditions under which these two classes were budded was not sufficient to effect the issue, or was masked by more potent factors.

Table IV

Record of rainfall in inches five days before and ten days after budding in tke field

	Days before budding					Day of budd-ing	Days after budding										Per-centage suc-cesses	Average
	5th.	4th.	3rd.	2nd.	1st.		1st.	2nd.	3rd.	4th.	5th.	6th.	7th.	8th.	9th.	10th.		
Area 1																		
Clone																		
H 411	—	—	—	·08	—	—	·11	·06	·10	—	·31	—	·04	·55	·10	·04	50·8	
Culcagb 5	—	—	—	·08	—	—	·11	·06	·10	—	·31	—	·04	·55	·10	·04	83·0	
Mirishena 2	·10	—	·31	—	·04	·55	·10	·04	·13	—	1·26	—	·47	·18	·53	·62	45·0	51·3
Mirishena 11	—	—	·31	—	·04	·55	·10	·04	·13	—	1·26	—	·47	·18	·53	·62	19·4	
Govinna 1836	—	—	·08	—	—	·11	·06	·10	·10	—	·31	—	·04	·55	·10	·04	58·6	
H 2	—	—	·13	—	·02	—	—	—	—	—	—	—	·08	—	—	—	71·4	
Nakiadeniya 10	·13	—	·02	—	—	—	—	—	—	·08	—	—	—	—	—	·20	88·1	
Eladuwa 1	—	—	—	·08	—	—	—	—	—	·20	·12	—	—	—	·13	·15	61·4	78·8
Yogama 21Y	—	—	—	—	·08	—	—	—	—	—	·20	·12	—	—	—	·13	88·1	
Wawulagala 120	—	—	—	·08	—	—	—	—	—	·20	·12	—	—	—	·13	·15	85·0	
Area 3																		
H 24	—	·31	—	·04	·55	·10	·04	·13	·80	—	1·26	—	·47	·18	·53	·62	60·9	
H 203	—	·08	—	—	·11	·06	·10	—	·31	—	·04	·55	·10	·04	·13	·80	83·0	65·6
H 47	—	—	·08	—	—	·11	·06	·10	·10	—	·31	—	·04	·55	·10	·04	52·8	
H 2	—	—	·13	—	·02	—	—	—	—	—	—	—	·08	—	—	—	47·5	
H 401	—	·13	—	·02	—	—	—	—	—	—	·08	—	—	—	—	—	93·5	
H 439	·13	—	·02	—	—	—	—	—	—	·08	—	—	—	—	—	·20	88·6	72·3
Milleniya 162	·02	—	—	—	—	—	—	·08	—	—	—	—	—	·20	·12	—	61·2	
Udapola 24	—	·02	—	—	—	—	—	—	·08	—	—	—	—	—	·20	·12	68·6	
Hillcroft 34	—	—	—	—	·08	—	—	—	—	—	—	·20	·12	—	—	—	74·3	

THE PERSONAL FACTOR

The personal skill of the budder has undoubtedly a potent influence on success. In the present case all the budding was done by two men, both of whom did a part of the budding of each clone, so that for comparative purposes the personal factor can be disregarded.

THE CONDITION OF THE BUDWOOD

This is probably the most potent factor in influencing the success of budding rubber. It is rather difficult to analyse the causes leading up to unsatisfactory peeling and general poorness of budwood. It appears certain that individual clones differ inherently in this respect but Mann has also pointed out the great variation in successes that he obtained from budwood from different trees of the same clone. It would appear that the quality of giving a large percentage of successes in budding is one which should have considerable weight in selecting a clone for extensive propagation. Apart from this it would appear hard to see what practical steps can be taken in the matter beyond ensuring as far as possible that the plants in the budwood multiplication nursery are in the most vigorous possible state.

REBUDDING OF FAILURES

The statement has been made in Ceylon that when a bud has failed there is little chance of success by rebudding the stock on the other side until a period of about four months has elapsed. While this may be true of small stocks it has been strikingly disproved in the present instance in the case of two-year-old stocks such as were used in area 3. As reserve stocks were in hand for replacing failures, and as, in the event of final failure, the original stock would in any case be uprooted it was thought worth while to rebud the original stocks on the other side when a failure was recorded. The results are found in table 5 altogether with the results of the original budding.

Table V

Percentage successes obtained by rebudding two-year-old stocks on the opposite side when the original budding had failed.

Clone	Pencentage successes of original budding	Percentage successes of rebudding on the opposite side of the stock
H 2	47·5	64·1
H 401	93·5	100·0
H 439	88·6	75·0
Hillcroft 34	74·3	82·1
Millenjva 162	61·2	79·0
Udapola 24	68·6	78·1
H 47	52·8	85·3
H 203	83·0	100·0
Average	71·2	82·9

All stocks were rebudded within two months of the original budding. One clone is not included as the second examination had not been made at the time of writing. It must be borne in mind that a considerably smaller number of stocks was dealt with in the rebudding than at the original budding, but the fact that the average percentage of successes obtained is actually higher than at the original budding while conditions were approximately the same indicates that it is well worth while re-budding large stocks again on tbe other side without delay.

COMPARISON WITH BUDDING IN THE NURSERY

No exact comparison with nursery budding is available in the present instance since the same clones (except H2) were not budded in the field and the nursery. The percentage of successes obtained by budding in the nursery (for area 2) is however given in table 6 for general comparison.

Table VI

Percentage successes obtained by budding on one-year-old stocks in the nursery.

Clone	Percentage Successes
H 2	78·9
H 75	·87·0
H 445	97·0
P 5	94·5
P 12	96·5
H 400	81·0
H 82	84·0
H 140	94·0
H 440	97·0
H 26	96·0
Average	90·6

The average percentage of successes is certainly considerably higher in the nursery than in the field but it must be remembered that the nursery budding was all done on vigorous one-year-old stumps. Better results in the field could have been anticipated on one-year-old stumps, though it is unlikely that they would have achieved the same vigorous growth as in the nursery.

ACKNOWLEDGMENT

All the budding work referred to was done under the immediate supervision of Mr. T. B. Ranaraja, Assistant in charge of the Iriyagama Division, who also took the records on which the conclusions arrived at in this article are based. He was assisted in this work by Mr. A. E. Wickramasinghe, Conductor.

SUMMARY AND CONCLUSIONS

1. The results of budding seventeen Ceylon clones in the fields are discussed.

2. It was found that there was no apparent advantage in the stock being in a state of active growth at the actual time of budding.

3. There was no apparent advantage in budding on dull days rather than on hot sunny days; in fact the highest percentages of successes were obtained under the latter conditions.

4. No budding was done under drought conditions but from an examination of the rainfall five days before and ten days after budding it appeared that a higher percentage of successes was obtained in the periods of lesser rainfall.

5. Considerable differences in the percentages of successes obtained were apparent in different clones and it is believed that the individual suitability of a mother tree for successful budding and the state of the budwood used are two of the most important factors influencing success.

6. It was found that large two-year-old stocks could be successfully budded on the other side soon after the original budding was definitely recorded as a failure.

7. Considerable greater success was obtained by budding on vigorous one-year-old stocks in the nursery than on stocks two years old or more in the field.

CONTRIBUTIONS FROM THE RUBBER RESEARCH SCHEME, CEYLON

REPORT ON SULPHUR DUSTING EXPERIMENTS ON GONAKELLE ESTATE

R. K. S. MURRAY, A.R.C.Sc.,
MYCOLOGIST,
RUBBER RESEARCH SCHEME (CEYLON)

1. *The Experimental Area.*—The total area of rubber on Gonakelle Estate is 93 acres, consisting of three fields of approximately 45, 40, and 8 acres respectively. The latter field is situated about $\frac{1}{4}$ mile distant from the main portion of the rubber, and served as an untreated control in the dusting experiments. Roughly speaking, the two main fields consist of relatively narrow strips planted down a steep hillside from an elevation of over 3,000 feet down to about 1,500 feet. Whereas one field is well roaded, having a path "zig-zagging" from the top to the bottom, the other has few paths, such as there are being badly placed for dusting purposes. This matter has an important bearing on the success of the operations, as indicated below.

The rubber is mature and well grown for so great an altitude, and has not been tapped for some years. Before the dusting was commenced the intensity of *Oidium* was judged to be approximately equal in the three fields, the extent of defoliation being, perhaps, slightly less in the control block. Every tree was affected to a greater or less degree, and it was estimated that approximately 30% of the trees had been completely defoliated. The fungus was active when dusting was commenced.

2. *The Dusting Operations.*—For the most part the Björklund Duster was used, as in the experiments in Matale. With the exception of a few minor points due to the vibration of the two-stroke engine the machine gave entire satisfaction. In conjunction with the dusting experiments a trial machine of British manufacture was tested.

Two kinds of sulphur were used:

(1) "Acme 300" sulphur dust manufactured in America.

(2) "Flotate" sulphur from the Kawah Poetih volcanic deposits in Java.

The price of the American sulphur f.o.r. Colombo is about 13½ cents per lb., whereas for the Java product the corresponding cost is about 6½ cents per lb., the difference in price being largely due to the heavy freight charges from America. The only advantage which the American sulphur appears to possess is that it may be used without any preliminary treatment. "Flotate" sulphur, on the other hand, must be dried in the sun for a few hours before use, and may be passed through a sieve to advantage. This operation, however, costs not more than about 1/10 cent. per lb., so that it would appear that the extra cost of the more specialised product is not justified. When satisfactorily dried "Flotate" sulphur possesses as good cloud-forming properties as "Acme 300," and its fungicidal properties appear to be at least as good. The conclusion that "Flotate" sulphur is preferable to "Acme 300" should not be interpreted as a general statement unfavourable to specially prepared American sulphurs. Price is a very important factor, and if an American firm can place on the Ceylon market a suitable article at a price competitive with that of Java sulphur, its use must be considered. At the present time it is not known whether the Java sulphur possesses any advantages over American sulphur on account of its acid content.

A total quantity of 6,200 lb. of sulphur was applied to the experimental fields on Gonakelle, 4,000 lb. of "Acme 300" dust being first applied in four applications followed by 2,200 lb. of "Flotate" sulphur in three applications. In all an average of 73 lb. per acre was applied. Mechanical trouble with the experimental machine somewhat interfered with the later dusting operations, with the result that portions of the rubber have received 7 applications while others have had only 6 dustings. The first application was made on May 7th, and 8th, 1930. Subsequent dustings followed at approximate fortnightly intervals, the final application being made on August 19th, and 20th.

Owing to the steepness of the land and scarcity of the paths in part of the experimental area each application occupied two days, so that an average area of only 42½ acres was treated per day. The dusting operation was confined to the mornings. The coolies were seldom able to return to the lines before about 2 p.m. and were not, therefore, required to work in the afternoons. All the work was personally supervised.

3. *Quantities and Costs.*—The following figures represent the approximate costs of the dusting operations on Gonakelle. It is impossible to give exact figures owing to the complications introduced by the testing of the experimental British machine. The figures are of little value as a gauge of the general cost of

sulphur dusting owing to the excessively high price of the American sulphur. Depreciation of the machine and cost of special supervision are not included.

			Rs.	cts.
Sulphur.	(1)	4000 lb. "Acme 300" @ 13·3 cts.	532	00
		2200 lb. "Flotate" @ 6·6 cts.	145	20
		(costs are excluding transport from Colombo)		
Labour.		140 coolies @ -/60 cts.	84	00
Petrol.		7 gallons @ Rs. 1-75	12	25
Oil.		1½ gallons @ Rs. 4-50	6	75
		Rs.	780	20

This is equivalent to about Rs. 9-25 per acre. It is again emphasised that this figure does not represent the economic cost of sulphur dusting in Ceylon.

4. *Results.*—Before reporting the results of the dusting experiments it is necessary to consider the condition of the foliage when the dusting was started and during the course of the operations. The normal "wintering" process occurs on Gonakelle during February, March, and April. When dusting was started on May 7th most of the trees had put on their new foliage and had suffered as the consequence of a severe *Oidium* attack. It was estimated that about 30 per cent. of the trees had been completely defoliated. These trees put out a second crown of foliage during the course of the experiments, so that there was at all times a proportion of the trees in young leaf. In addition a considerable percentage of trees underwent a secondary "wintering" in July and August so that there was a large quantity of young leaf in August and early September. This secondary "wintering" is normal in parts of Uva and is doubtless due to a prolonged period of dry weather following the N. E. Monsoon.

Oidium was active throughout the course of the experiments but did not cause as severe leaf-fall as in March and April. It became more virulent in the control field after the normal secondary wintering referred to above, and its increase in virulence appeared to be associated with the advent of showery weather.

It may at once be stated that the benefit in the foliage due to the sulphur dusting was disappointing. This is considered to be chiefly due to the fact that the dusting was carried out at the wrong time of the year. It was the intention to commence dusting early in April, but owing to unforeseen delays in shipping the sulphur from America, the start was postponed until May 7th, by which time the foliage had already suffered severely from the disease. As far as the control of the fungus is concerned, however, very definite results were obtained.

In considering the results of the dusting it is necessary to distinguish between the two treated fields. It has already been mentioned that whereas one field is well "roaded," the other is poorly provided with paths. In order to determine whether it is necessary to apply the sulphur carefully to every portion of the rubber, or whether, once a good cloud of sulphur has been projected, the breezes will effectivly distribute it to all parts, the latter area was dusted chiefly from such paths as existed. As a consequence the treatment was comparatively ineffective, and only those portions of the field to which the sulphur could be easily applied have benefited to any marked extent. The valuable conclusion is drawn that it is of the utmost importance to ensure that every portion of the rubber receives its full quota of sulphur. On steep land this is often a matter of great difficulty, and would probably be a limiting factor to the success of sulphur dusting on some mid-country estates. Attention is directed below to the results obtained on the well "roaded" field in which it was possible to dust every portion from the paths.

The foliage of the dusted and control fields was carefully examined on September 4th and 5th, and the following points were noted:

(1) In the dusted field about 15 per cent. of the trees were or had recently been in young leaf, and in every case examined the preceding defoliation was of the normal secondary type described above. In the control field the corresponding proportion was about 30 per cent. the defoliation in about half these cases being due to *Oidium* attack in the previous month or two.

(2) In the dusted field 38 trees in young leaf were examined, and in every case *Oidium* infection was either absent or slight. Leaf-fall was negligible. In the control field 48 such trees were examined, *Oidium* infection being classed in all cases as moderate or severe. The extent of leaf-fall was considerably greater than in the dusted field.

(3) There was an abundance of healthy flower in the dusted field, and a small quantity in the control.

(4) A small number of trees in the dusted field which had defoliated during the dusting operations appeared to be quite free from the disease, while, of a total of 240 trees examined, 91 per cent. showed only mild secondary attack. In the control field no entirely healthy trees were found, and the proportion with mild secondary attack was 10 per cent.

(5) A large percentage of trees in both areas possessed a thin crown of distorted leaves, mainly the result of *Oidium* attack before the dusting operations were commenced.

The above remarks apply only to the control field and the well "roaded" dusted field.

5. *Conclusions.*—As the result of the dusting experiments and other observations on Gonakelle the following conclusions have been drawn:

(1) "Flotate" volcanic sulphur from Java is as effective a fungicide as the more specially prepared "Acme 300" dust from America, and is preferable on account of its cheapness.

(2) In order that the dusting operations should achieve the maximum success they should be carried out during the period of refoliation after the normal "winter." The applications on Gonakelle were started too late in the year. It is probable that the first application should be made at the first appearance of young leaf after "wintering." This matter is to be investigated in further experiments to be carried out in Matale.

(3) The importance of ensuring that every portion of the rubber receives its full dose of sulphur is stressed. Steep land with few convenient paths may be very difficult and slow to dust effectively.

(4) Severe attacks of *Oidium* appear to be associated in the Passara district with showery weather. This may appear at first sight to be contradictory to the previous conclusion that a dry atmosphere is the most important climatic factor favouring the disease. It must be noted, however, that Passara is a dry district, and the humidity between showers is relatively low. It is possible that the showers provide the quantity of moisture necessary to the vegetative growth of the fungus mycelium, the intervening dry spells being favourable to the production of the conidia.

(5) Although the dusting operations, as judged by the general appearance of the treated rubber, cannot be considered highly successful, it is considered that the experiments, as such, have fulfilled a useful purpose in elucidating several problems in connection with the treatment.

6. *Acknowledgment.*—Thanks are due to Mr. G. Kent Deaker, Superintendent of Gonakelle Estate, for his kind co-operation in these experiments.

REPORT IN CONNECTION WITH VISIT TO THE EAST

A COMPARISON OF METHODS OF PREPARING PLANTATION RUBBER IN CEYLON, MALAYA AND JAVA

G. MARTIN, B.SC., A.I.C., F.I.R.I.,
SUPERINTENDENT CHEMIST IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME

FUNDAMENTAL factors which may affect the preparation and properties of rubber in the three countries are differences in type of soil and differences in temperature and humidity.

Soil.—In Ceylon most of the rubber is grown on undulating land some of which is covered with huge boulders. Neither in Malaya nor Java are conditions so hilly. The impression gained was that agricultural operations and latex collection are difficult in Ceylon, somewhat easier in Malaya and least difficult in Java. There are considerable differences in the appearance and physical texture of the soil in the three countries, but no opinion of value as to their comparative fertility could be formed in the short time available.

Climate.—The temperature in the rubber growing districts of Ceylon is about 5° lower than in Malaya and Java. For this reason fermentation of latex does not occur so readily in Ceylon. The lower temperature affects the growth of the trees and the rate of bark renewal. The trees take longer to reach maturity in Ceylon and it is customary during tapping to take much thinner shavings than elsewhere to allow for slower bark renewal.

Although the rainfall is abundant in all three countries the atmosphere in Ceylon is not so heavily charged with moisture. Crepe rubber can therefore be dried in less than a week when the weather is favourable, whereas in Java* it is necessary to employ artificial heating at night-time and in Malaya great care is necessary with regard to the position, dimensions and ventilation of the drying room.

During my visit there was a considerable amount of morning rain in Ceylon which interfered with tapping. The tapping intervals were therefore very irregular. Malaya and Java were more fortunate. Whilst the main features of rubber preparation are the same in all three countries, differences in detail have developed and the following is an attempt to summarise them.

* The preference for artificially heated drying sheds for crepe rubber in Java is in much lesser way a consequence of an extraordinary high content of moisture in the air than of the desire to be independent of the climate and the time of day as well as to be able to manufacture a rather thickish crepe in order to obtain a higher working capacity of the milling battery. During the dry season crepe rubber in Java will be dry in air at ordinary temperature within a week's time, just the same as in Ceylon. By employing artificial heating the danger of developing mould on crepe even in exceptionally cold and rainy weather is practically nil.—(Comment by the Director of the Java Proefstation voor Rubber).

Operation	Ceylon	Malaya	Java	Comments
Tapping	Half spiral cut 4-6 ins. per annum.	Chiefly V cut 9-12 in. per annum.	Half spiral cut 9-12 ins. per annum.	Ceylon cuts are thinner and less steep than elsewhere owing to slower bark renewal caused by climatic differences.
Latex collection	Latex is collected in coconut shells hung on an ingenious type of spout. After the collection of the latex the cups are sometimes inverted on sticks or left lying on the ground.	Latex is collected in porcelain or glazed earthenware cups hung on wire loops round tree. Glass cups are sometimes used. Aluminium cups are not favoured because they quickly become hot in immature areas and during the wintering season, and the film of latex left in the cups after collection becomes tacky.	Latex is collected chiefly in aluminium cups hung on loops round trees. These are taken every day to the factory by the tappers, thoroughly cleaned and dried and inspected by the factory assistant.	The temperature in the rubber growing districts of Ceylon is lower than in the other countries and fermentation of the latex, causing bubbles in the rubber, does not occur so readily. Hence there is not the same obvious need for cleanliness. It is probable that strict attention to the cleanliness of cups in Ceylon would result in an improvement in the average inherent quality of rubher from the Island.
	*To prevent premature clotting an anticoagulant is necessary on a few estates and for this purpose sodium sulphite is used.	It is frequently necessary to employ an anticoagulant to prevent premature clotting and for this purpose sodium sulphite is used.	The addition of anticoagulants is seldom necessary. Sodium carbonate is officially recommended as a remedy against premauture clotting in the case of sheet manufacture and sodium sulphite for crepe.	The use of sodium carbonate as an anticoagulant was found to cause bubbles in Ceylon and Sumatra. Some technologists prefer ammonia as an anticogulent as it lowers the viscosity of the latex and enables dirt to settle out more easily. The possible effect of ammonia on brass in strainers resulting in the presence of copper in the rubber was discussed at the Java Conference *but no definite* conclusion was reached. This is a point which requires investigation.

* Sodium sulphite has the disadvantage of delaying drying and absorption of smoke. Ammonia would probably be more satisfactory but has not been tested in Ceylon (Comment by Chemist in Ceylon—T. E. H. O'Brien).

Operation	Ceylon	Malaya	Java	Comments
Latex treatment	Rubber content of latex determined by metrolac or glass hydrometer.	Rubber content of latex determined by metrolac. Daily crop estimates are usually made by weighing the wet rubber after a definite period of dripping, making allowance for the moisture content. For the estimates of dry rubber content of preserved latex for export trial coagulations are made.	Rubber content of latex determined by trial coagulation and crepeing.	The Java Proefstation voor Rubber considers that the use of specific gravity instruments for the determination of the dry rubber content of latex is unsound. Scientific workers in Malaya do not consider latexometers as accurate as trial coagulations, but consider them sufficiently accurate for the control of standardisation of latex for coagulation purposes. The opinion in Ceylon is that the results given by glass hydrometers are as accurate as those given by trial coagulation, as carried out on estates.
	Latex strained before dilution.	Latex strained before dilution. Settling tanks are now being installed in which diluted latex is placed, in order to separate sand. Vertical sieves for straining which have been used on *a few estates for years* are being recommended for all estates.	On some estates elaborate sieves are built into tanks for straining before and after dilution.	Great interest was displayed at the Java Conference in a series of graded vertical sieves; which allowed the dirt to settle to the bottom of the containing vessel so that there was less likelihood of dirt penetrating through the meshes of the sieve.
	*More acetic than formic acid is used for coagulation.	More formic than acetic acid is used for coagulation.	More than 90 per cent. of the estates use formic acid for coagulation.	

* The use of formic acid is extending in Ceylon and probably now exceeds that of acetic acid. It causes difficulty in sheet manufacture on certain estates owing to rapid coagulation. (Comment by Chemist in Ceylon, T. E. H. O'Brien).

Operation	Ceylon	Malaya	Java	Comments
Crepe manufacture				
(a) bulking and dilution	Latex as received is poured into Shanghai jars and then diluted to 20 per cent. dry rubber content.	Latex as received is usually poured into Shanghai jars and diluted to 20 per cent. dry rubber content.	Latex is bulked in tiled tanks in factories visited and diluted to 20 per cent. dry rubber content.	
(b) bisulphite	Bisulphite is added to obtain pale colour.	Bisulphite is added to obtain pale colour.	Bisulphite is added to obtain pale colour.	
(c) period coagulum in serum	Coagulum is removed the day following the addition of acid.	Coagulum is removed the day following the addition of acid.	Coagulum is removed the day following the addition of acid.	
(d) machining	Coagulum machined about five times.	Coagulum machined about twelve times.	Coagulum machined about twelve times.	The coagulum in Ceylon is mostly converted into lace crepe which is blanketed when dry. In Malaya and Java the coagulum is converted into thin crepe of even texture which requires no further treatement when dry.
(e) drying	The drying room is usually over the factory, and when the weather is favourable the crepe can be dried in 5 days. In some factories the crepe is dried by heating in air at 140°F for 45-60 mins. In this case it is rolled on to drums in layers and cut into mats. Hot air drying is more expensive than drying in air at ordinary	The drying room is frequently over the packing room. Crepe takes 9 days or more to dry.	It is usual to heat drying room at night with hot water pipes; otherwise the crepe may take as long as 21 days to dry.	The "mat" method of drying employed on some estates in Ceylon should be more widely known.

Operation	Ceylon	Malaya	Java	Comments
(e) drying (*contd.*)	temperature and is being discontinued. It is found that crepe dries as quickly in air without heat in mat form as in single lengths. This method is therefore employed on a number of estates with a considerable saving in space and labour.			
(f) principal defect	Mouldy crepe due to slow drying in wet weather gives considerable trouble on some estates. On blanketing this causes a discolouration of the crepe. The remedies suggested by Mr. O'Brien were cleanliness, washing drying room with 2% formalin, and the use of paranitrophenol.	Spot disease due to slow drying or dampness.	Spot disease due to slow drying or dampness.	The defects in Ceylon are peculiar to blanket crepe and those in Malaya and Java to thin crepe.
Sheet manufacture				
(a) bulking	Latex as received is usually poured into Shanghai jars. A few estates employ bulking tanks.	Latex poured into tanks.	Latex poured into tanks.	
(b) dilution	Diluted to 15% dry rubber content.	Diluted to 15% dry rubber content.	Diluted to 15% dry rubber content.	

Operation	Ceylon	Malaya	Java	Comments
(c) coagulation	Acid added, in jars or tanks and the latex transferred quicky to dishes. Sometimes latex is coagulated in shallow troughs and the coagulum handled in long lengths.	Acid added in tanks and vertical partitions inserted.	Latex transferred to dishes and acid added to each dish.	A study is being made at the Rubber Research Institute, Malaya, *with regard to the most* suitable depth of tank.
(d) period coagulum in serum	Coagulum machined the day after the addition of the acid.	Coagulum machined the day after the addition of the acid.	Coagulum machined the same day as the addition of the acid.	
(e) machining	Coagulum passed through a series of hand rollers on most estates.	Coagulum passed through a series of power driven rollers.	Coagulum passed through a series of power driven rollers.	One estate manager in Malaya had studied the *machining of* sheet very thoroughly and by increasing the depth of latex in the coagulating tanks thus producing a wider sheet, and by speeding up the machines had appreciably decreased the cost of this operation. The problem is also under investigation at the Rubber Research Institute, Malaya.
(f) soaking and dripping	Wet sheets allowed to drip in shade for about an hour.	Wet sheets allowed to drip in shade for about an hour.	Sheets soaked overnight in water and then allowed to drip.	The soaking process in Java is stated to prevent the develop*ment of mould.*

Operation	Ceylon	Malaya	Java	Comments
(g) smoking	Sheets smoked to a fairly dark colour. Many types of smoke-house.	Sheets smoked to a light colour. Elaborate smoke-houses.	Sheets smoked to a dark colour. Cheap smoke-houses which are probably efficient.	Professor de Vries expressed the opinion that it was unwise to encourage the market to demand a light coloured smoked sheet which might become mouldy very easily. The Rubber Research Institute, Malaya, is continually advocating the preparation of a darker smoked sheet. Considerable interest in the construction and dimensions of smoke-houses is being taken in Ceylon and Java and improvements are to be expected in the next few years.
(h) mould prevention	Paranitrophenol is used on a number of estates. Sometimes the sheets are soaked in it and sometimes it is added along with the coagulant.	Paranitrophenol was used extensively during the restriction period, but owing to additional cost its use has decreased considerably now that rubber is again placed on the market shortly after preparation.	Paranitrophenol is not required.	Machining on the day of coagulation, followed by soaking and heavy smoking in Java, tends to produce a sheet which vulcanises as slowly as crepe in a rubber-sulphur mixing.
(i) packing	Lining sheets used in packing. The rubber is not usually pressed into cases on account of complaints of massing. The cases therefore contain somewhat less than 220 lb. of rubber (170-180 lb.). 224 lb. per case is recommended by the Rubber Research Scheme.	Lining sheets are used in packing of the same grade as the contents. The rubber is usually pressed into cases which hold 224 lb., so that ten cases contain exactly one ton of rubber. In the case of thin crepe about 175 lb. are pressed into each case.	Lining sheets used in packing. The rubber is pressed into cases which hold about 220 lb.	An estate in Malaya supplying direct to the manufacturer baled all its rubber. The massing of rubber is of no importance unless the rubber has to be resorted at the docks or used by manufacturers without adequate machinery.

AGRICULTURAL COLLEGE ... LIBRARY No. 28135 17 MAR 1933

GENERAL COMMENTS ON METHODS OF PREPARATION

A. *Preparation of intrinsically uniform rubber.*—Owing to local modifications in the method of preparation it is to be expected that there will be general differences in the vulcanising properties of rubber from Java, Malaya and Ceylon. The most striking is likely to occur in the case of smoked sheet which, owing to machining soon after coagulation, soaking in water overnight, and heavy smoking, probably vulcanises more slowly when obtained from Java than when obtained from Ceylon or Malaya.

On the whole it is considered that methods of preparation do not differ greatly on estates in the same country and that the important source of variability is due to the varying characteristics of individual trees (see de Vries, Estate Rubber, p. 50). As long as rubber is the product of life processess in a tree it will not be possible to obtain strictly uniform material without submitting it to drastic chemical purification. Nevertheless it is possible to prepare much more uniform material than at present. For this purpose bulking on a large scale should be encouraged and when the standard method of preparation is found to yield a material with abnormal vulcanising and mechanical properties the method of preparation should be modified (Cf. Programme of Work, January 1st, 1930). This is the practice in connection with the preparation of "Certificate Rubber" in Java. Professor de Vries considers that the demand for this type of rubber is disappointing. On the other hand it is possible that the rubber is not as uniform in manufacturing operations and service as the laboratory tests indicate (Cf. Dinsmore and Zimmerman, Ind., Eng., Chem., 18, 1926, p. 144). It is important that the results of laboratory tests should bear a relation to results obtained in commercial practice, and this is a subject to which a considerable amount of attention has been given by the London Staff of the Rubber Research Scheme. The information obtained is of practical value in connection with the attempts now being made to encourage the preparation of uniform rubber throughout Ceylon.

As the area under budded rubber increases variations in the properties of rubber will probably decrease, particularly if care is taken to ensure that no tree is used as a source of budwood which yields rubber with abnormal properties when prepared by a standard method. This question is under consideration in London and has been studied elsewhere (*India Rubber Journal*, November 16, 1929, p. 159).

When the rubber tree population becomes less mixed it may be possible to prepare uniform rubber throughout Ceylon by a careful standardisation of the processes of preparation, but at present local modifications are necessary.

Acting Director, Rubber Research Institute, Malaya.

Comment by B. J. Eaton.—"In Malaya, I consider the lack of uniformity is due mostly to differences in methods of preparation on different estates. The considerable bulking of all the latex on any one estate eliminates differences due to varying characteristics of individual trees. The fact that the rates of vulcanisation of smoked sheet and thin pale crepe in Java are very similar, is probably due to the machining on the day of coagulation and the soaking overnight in water, whereas the coagulum for crepe manufacture is machined on the day after coagulation.

"The more rapid rate of vulcanisation of sheet compared with thin pale crepe in Malaya is due to the fact that generally the coagulum for both sheet and crepe is machined on the day after coagulation."

Author's Comment.—The views expressed in this report are partly based on results obtained with crepe and sheet from latex from different estates in Ceylon using the same method of preparation. The question is receiving attention in connection with the survey of the intrinsic quality of Ceylon rubber now being made.

B. *Dirt.*—Very few estates realise how important it is to keep out of the latex fine particles of dirt which are too small to be removed by straining. The use of *sheraties* (coconut shells), which is the general practice in Ceylon, is a doubtful economy and may be more instrumental in limiting the use of rubber than is generally realised.

Comment by B. J. Eaton.—"During this year much attention has been paid to this problem and large scale experiments have been carried out by the Chemical Division of the Rubber Research Institute of Malaya on estates. A vast improvement has been effected by (a) use of settling tanks in which diluted latex is allowed to stand for about 10-15 minutes before straining and transfer to coagulation tanks, and (b) by the advocation and use of vertical strainers."

Village Sheet.—An interest was taken in the preparation of smoked sheet rubber on small holdings in Ceylon. As the latex from which the individual sheets are prepared is obtained from a small group of trees, the rubber must be variable, but it is probably averaged by the various brokers who handle it. Nevertheless it is expected that batches of 100 lb. will vary more than the corresponding amounts from large estates. The method of sun drying is open to criticism as it may cause deterioration of the rubber.

Comment by B. J. Eaton.—"In Malaya co-operative factories and smokehouses are being started to improve and render such rubber more uniform. It is also anticipated that a higher market price equivalent to that obtained by large European managed estates will result."

For the information contained in this report the author acknowledges his indebtedness to Professor de Vries and Dr. Riebl in Java, Major B. J. Eaton in Malaya and Mr. O'Brien in Ceylon who all devoted a considerable amount of time to enable him to obtain the maximum advantage of his tour in the East. He also appreciates their kindness in correcting and commenting on this report.

A FRUIT INDUSTRY FOR THE GOLD COAST*

THE GOLD COAST CLIMATE

THE Gold Coast is situated wholly within the torrid zone and has a mean annual rainfall between 24 inches in the coastal savannah and 88 inches in the rain forest. There is a marked double rainy season.

The mean annual shade minimum temperature in the coastal savannah lies between 71 and 75 degrees, the mean annual shade maximum for the same type of country being 83°-87°. In the rain forest mean shade minimum falls between 67° and 71° with a mean maximum of 83°-89°.

The mean temperature range in the inland savannah is generally greater, reaching 26° in some districts.

The mean annual relative humidity lies between 71 and 88 per cent. with a very marked drop to as low as 20 per cent. in the Harmattan season, during December and February.

A FRUIT INDUSTRY FOR THE GOLD COAST

An industry in the fruit mentioned is limited at the present time to *Lemons* and *Grape Fruit,* these crops being easily cultivated and handled. The most important factor however is that the fruit would be easily marketable in the United Kingdom as compared to other fruits, which would have to meet severe competition from other countries.

COMMENCING THE INDUSTRY

The industry being a specialised one, where care is required in cultivation, selection of varieties, weeding, mulching, pruning, reaping, handling, grading, packing and shipment, it is obvious it would be useless to attempt the cultivation of either lemons or grape fruit in the same manner as cacao is cultivated by the majority of the farmers at the present time. A number of individually owned plantations with a central packing house, or plantations commenced on a bonus system, as has been done with coffee in this Colony, even with co-operative management, would be doomed to failure from the commencement.

The trees have to be grown on plantation principles and receive care and attention throughout the whole period from seedlings to old age, and the fruit "picked." No fruit of any description is picked in this country and even on Agricultural Stations, unless supervised by a European, the method of collecting is by beating or shaking the branches and allowing the fruit to fall to the ground.

Having regard to the primitive methods of Agriculture in force at present and to the temperament of the African, the industry would have to be commenced and managed by Government, unless a European firm or company with a knowledge of, or interest in, the fruit industry, could be induced to obtain a concession for the purpose.

RAINFALL, SITUATION, SOIL

(a) *Grape Fruit.*—In the United States the trees are grown in many districts on every sandy soil with very low rainfall which requires irrigation. Large and good crops are produced under these conditions but insect pests cause a considerable amount of damage and production costs are ralatively high.

---

* By G. H. Eady, (Gold Coast) in *Bulletin* No. 20 of the Department of Agriculture, Gold Coast.

At Aburi with a rainfall of 48 inches good crops are produced but in general a rainfall of under 50 inches is undesirable. In the West Indies grape fruit cultivation is successful in a high rainfall area of 250 inches per annum. A district with a rainfall of over 50 inches should be chosen and this should be fairly evenly distributed.

A site near a motor road or railway is an obvious advantage, other conditions being suitable, and should be chosen with due regard to the soil and rainfall conditions necessary. Flat land is suitable provided it is well drained but land with a moderate slope is preferable.

The best soils are deep loams, fertile, and well drained. Shallow, heavy, poorly drained soils are unsuitable and clay soii should be avoided. Trees on good fertile soil will produce heavy crops without the use of irrigation or artificial manures and production costs will be at a minimum. Many suitable situations exist in the Gold Coast.

(b) *Lemons.*—At Aburi, elevation 1,500 feet, rainfall 48 inches, the trees grow well and produce fairly good crops on very poor soil. The tree requires practically similar conditions of rainfall situation and soil, as the orange. The tree luxuriates in the tropics, grows well in the sub-tropics and will endure the mild frosts of the South of France. A rainfall above 50 inches is advisable, although in well-watered districts the trees will probably fruit well on less than this. A very humid atmosphere is detrimental to the production of good fruit, whilst a short resting period, such as is encountered during the Harmattan season, would be distinctly beneficial.

Conditions as to suitable situations are the same as required for grape fruit. The higher elevations up to 4,000 feet are preferable but unobtainable in this country. Strong winds are a disadvantage and strong sea breezes definitely harmful.

The type of soil in which lemons luxuriate is of a light rich nature on a marly or limestone formation, but the tree does well on any good rich soil such as may be found in many places in the Western Province of the Colony in well-watered areas.

SUPPLY OF PLANTS AND PLANTING MATERIAL

(a) *Grape Fruit.*—The most desirable characteristics are, thinness of skin, fine texture, yet strong enough to stand up to the handling and travelling necessary, smoothness, good and even colour without roughness or corrugations, and fruit of good shape. A minimum of seeds, pith and rag, is desirable, but sweetness is of little importance, providing the fruit possesses high juice content with a brisk and distinct flavour and is free from bitterness and too much acidity.

Certain trees at Aburi and on othei Agricultural Stations possess these characteristics and large numbers of seedlings could be raised by budding on to sour orange stocks. "Marsh's Seedling," "Duncan," "Excelsior," "Hall," "McCarty," and "Triumph," varieties are being imported by the Department and budded plants could be raised from these.

(b) *Lemons.*—The chief characteristics desirable are good colour, smooth, even, thin yet tough skin and a brisk and distinct flavour. Fruit approximating to these desiderata exist at Abrui and on other stations Large numbers of budded seedlings could be raised on sour orange stocks or from seed if necessary. The Department is importing the following varieties from all of which budwood would be available within a few years: "Eureka," "Lisbon," "Villafranca," "Genoa," "Spanish."

NURSERY AND SEEDLINGS

(a) *Grape Fruit*: (b) *Lemons.*—Numbers of grape fruit and sweet orange trees in this country are destroyed by gummosis of the collar and stem for which reason a resistant stock is essential. The sour or Seville

orange is resistant or nearly so; and possesses certain other desirable characteristics of value. The first, or one of the first, operations after acquiring the land chosen for the plantation would be the selection of a site suitable for nursery. The seedbed need not be raised from the ground unless local conditions require such practice and seed from healthy, vigorous, well-grown trees obtained, preferably from only one tree. When the seedlings are *about 8 inches high they should be transplanted into the nursery*, 15 inches apart and 3 feet between the rows, taking care to discard all small, weak and diseased plants and those with deformed roots.

Budding may be undertaken whenever the seedlings are large enough and preferably about 10-12 inches from the ground, otherwise the stem may develop gummosis or collar rot. Small and backward seedlings should be destroyed. The usual practice should be followed in this operation which presents no real difficulties in this country. Budwood should only be cut from trees known to produce the right type of fruit in abundance and only from such trees as show the least tendency to single limb mutation.

Budwood may be kept for some time under suitable conditions transported to the nursery by the most direct route, or alternatively, seedling stocks could be raised and budded in the vicinity of the parent trees and the budded plants transported to the plantation.

PLANTING

(a) *Grape Fruit.*—All natural growth should be removed from the selected area and holes dug 25 feet by 25 feet apart each way. When removing plants from the nursery to the plantation all weak trees should be discarded as they are inferior to the well-grown ones and will always remain so. Young plants should each be provided with a stake to which they must be tied to encourage straight stems.

The actual planting operation would naturally follow the standard practice and needs no description here.

(b) *Lemons.*—A planting distance of 20 feet by 20 feet is recommended which gives 109 plants to an acre. A greater or lesser distance may be necessary according to the type of soil otherwise the procedure would be the same as given under grape fruit.

CARE OF THE YOUNG PLANTATION

(a) Grape Fruit and (b) Lemons.—Until such time as the trees come into good bearing the young trees require continual attention. Vacancies should be filled as soon as they occur in order to obtain trees of uniform growth.

Clean weeding is not recommended except for an area extending for three feet either side of each tree. Weeds and bush may be cutlassed when necessary and the trees mulched with the weeds cut from the centre of the rows. Pruning should be confined to removing branches and suckers that arise from undesirable positions and crossed branches, the object being to produce well-balanced trees with fairly open centres.

Whilst the grape fruit and orange require only a minimum amount of pruning the lemon tree demands almost constant attention. The tree should be regularly pinched back and built up wholly of short stocky branches strong enough to bear a heavy load. The tree should not be allowed to grow more than 8 feet to 10 feet high and all suckers and vigorous shoots removed as occasion demands.

CULTIVATION

With a medium rainfall, clean weeding of young grape fruit or lemon plantation is not recommended since the valuable surface soil would be lost by erosion and humus content quickly destroyed, apart from the damage to the feeding roots which lie close to the surface.

Cover crops should be encouraged whenever possible.

The addition of fertilisers will probably be necessary when the trees commence to bear but, provided good crops are produced, may not be required.

PROBABLE YIELD

(a) *Grape Fruit.*—Trees in full bearing are capable of yielding 500 fruits per tree.

A yield of 20,000 fruits per acre is within the limits of a healthy plantation.

Records of the individual yields of trees both at Tarkwa and Aburi, where the soil is very poor, average 300 fruits per tree over a period of several years. In this country there is a double fruiting season extending from March to June and September to December, the greatest proportion of fruit being produced during the earlier season.

(b) *Lemons.*—The fruiting season is much more irregular than with other citrus fruit, being produced in this country throughout the greater portion of the year. Pruning is an important operation in relation to production but if properly carried out good trees will yield 400-500 fruits per tree or 40,000 per acre per annum.

PICKING

(a) *Grape Fruit.*—This operation is as important as the actual production of the fruit and should receive very great care. Fruit must not be dropped or bruised or suffer mechanical damage whatsoever; otherwise a large percentage will be decayed before reaching distant markets.

Pickers, in addition to being taught that extreme care is necessary in handling the fruit, should wear gloves to avoid finger nail marks. Other points requiring attention are (*a*) The use of a type of clipper that will not injure the fruit. (*b*) Containers must be free from roughness, sand splinters, or any material likely to damage the fruit. (*c*) The stem must be cut flush with the button and no portion allowed to project beyond the fruit otherwise punctures will occur. (*d*) Fruit must not be piled over 12 incbes deep. (*e*) Fruit must not be picked when wet or during wet weather. (*f*) Fruit must not suffer from prolonged exposure to the sun. (*g*) Fruit should be fully mature before being picked and of a degree of ripeness that by the time they reach the consumer tbey are fully ripe and of a pale lemon yellow colour.

(*b*) *Lemons.*—The same care in handling, prevention of damage, and mechanical injury is required as with grape fruit but the fruit must be picked in a green or semi-ripe condition and artificially coloured. At Aburi the fruits do not ripen uniformly and attain a good colour if left on the trees and it is safe to assume that they would not do so when grown on a large scale in other parts of the Colony. Artificial ripening also allows fruits to be picked when of uniform size, stored for several months and placed on the market when prices are most favourable.

GRADING AND PACKING

(a) *Grape Fruit.*—Cases recommended are of the same type as those used in South Africa, the inside measurement being, length 23 inches, breadth 11½ inches, depth 11½ inches with a central division across the breadth. These could be manufactured locally providing suitable timber was available or shipped out in shooks made of Swedish white wood. The use of standard cases is essential.

Fruit must be entirely free from surface marking of any description and each fruit must be wrapped in tissue paper. Cases should be packed to counts of 64, 70, 80 and 96 fruits and stencilled accordingly. The fruits should be firmly packed but not so tight as to cause the wood of the case to cut intc the fruit.

(b) *Lemons.*—Standard cases should be used, each fruit separately wrapped in tissue paper and packed to a count of 300 per crate, the same general care being required as for grape fruit.

Artificial colouring may be effected by exposing the green fruit to carbon dioxide and carbon monoxide gas in a humid atmosphere of 90.° The process occupies about six days.

The following method in use in New South Wales is taken from a description of the process adopted by the Department of Agriculture in that country.

The actual operation was conducted thus:

The fruit just picked into "lug" boxes was stacked on pieces of wood battens resting on an earth floor. The head of boxes was then covered with a heavy canvas cover, thus enclosing the stack of fruit in practically an airtight condition. An oil engine of 2 P.H. attached to a motor spray machine was used from which the exhaust gases were conducted by a pipe sufficiently long to prevent the temperature of the fruit rising above 75°F. (piping 12 feet long was necessary).

The engine was run intermittently for five days. The actual engine running time was 61 hours, but probably the colouring could be accomplished with less engine running. The cost of oil and benzine for each experiment was 15s. 8d., and up to 97 bushels of fruit were treated at one time. It is believed that the exhaust gases were ample for treating at least three times that quantity of fruit.

In addition to keeping the temperature around 75° it is important to maintain a humidity of not less than 80%. This was accomplished by spraying water on to the ground beneath the boxes when humidity showed a declining tendency.

SHIPMENT

The Gold Coast is in direct shipping communication with England, the voyage taking 13 days.

With careful handling and packing, it is not essential that grape fruit and lemons for the English market should be refrigerated in transit. Messrs. Elder Dempster's steamers have cool room stowage available which it would be necessary to use if other stowage was not available. With a progressive firm like Messrs. Elder Dempster & Co., however, it is fairly safe to assume that shipping difficulties, should they arise, would be solved even to the extent of running special steamers if and when the industry should warrant such provision.

MARKETING

The geographical position of the Gold Coast is such as to make it compare favourably with other Colonies interested in citrus culture, since its only competitor of any importance at present would be South Africa, whose fruits take practically a week longer to reach the market than would fruit from the Gold Coast. It must, however, be remembered, that Sierra Leone are very seriously considering the citrus fruit market and in the case of this trade developing they will be able to get their fruit over in three or four days' less time.

Detailed arrangements as to marketing the fruit would have to be made beforehand with wholesale fruit salesmen such as Messrs. Broome and Green, Messrs. J. and H. Godwin & Co., or other prominent firms. It would be advisable to mark on each crate, before shipment the nature of the contents and number of fruit per case.

COSTS

(a) *From Seedling to Bearing Trees.*—Assuming 20 acres of land is planted to commence with, the cost of bringing the plantation into bearing would approximate to the following:

		£	s.	d.
Cost of trees	... ...	35	0	0
Clearing	... ...	150	0	0
Planting	... ...	3	0	0
Pruning, etc.	... ...	5	0	0
Treating diseases	... ...	5	0	0
Cutlassing, weeding	... ...	250	0	0
Mulching, etc.	... ...	50	0	0
		£498	0	0

The cost of bringing an acre of grape fruit to the bearing stage should not cost more than £25 per acre in this country. In the case of lemons this cost would be slightly greater on account of the extra number of trees required and a greater expenditure on pruning. This should not, however, exceed £30 per acre.

(b) *Maintenance Costs after Maturity per acre per Annum:*

	Grape Fruit			Lemons		
	£	s.	d.	£	s.	d.
Pruning ...	1	0	0	2	0	0
Cultivation ...	3	0	0	3	0	0
Treating, diseases, etc. ...	1	10	0	1	10	0
Fertilisers ...	6	0	0	6	0	0
Per acre per annum	£11	10	0	£12	10	0

(c) *Estimated Cost of Landing Fruit in England per Case:*

	Grape Fruit (per box of 60)			Lemons (per box of 300)		
	£	s.	d.	£	s.	d.
Cost of Production ...	0	0	6	0	0	9
Picking ...	0	0	2	0	1	0
Packing and material ...	0	0	3	0	0	5
Cases ...	0	0	6	0	0	6
Transport ...	0	0	6	0	0	6
Freight to England ...	0	3	0	0	3	0
Commission, United Kingdom charges, etc. ...	0	2	0	0	2	0
	£0	6	11	£0	8	2

A yield of 363 boxes of grape fruit, containing an average of 77 fruits should be obtained per acre and 133 boxes containing 300 fruits in the case of lemons.

WHOLESALE PRICES IN THE UNITED KINGDOM

(a) *Grape Fruit.*—An examination of the wholesale prices of grape fruit in the United Kingdom reveals very considerable fluctuations not only from one part of the year to the other, but even in any one month. There are naturally also the ordinary variations in prices on any one date due to differences in quality and picking.

As an illustration, Jamaican grape fruit may be taken. At Liverpool during the past 12 months, according to the market report of a well-known firm of fruit merchants, the price of this fruit has fluctuated between 10s. 9d. and 17s. in November, and 31s. 6d. and 46s. in September.

Another striking case is that of Florida grape fruit where quotations have varied between 12s. to 19s. 3d. and 26s. to 40s. which was obtained in May.

The highest prices were, however, obtained by Porto Rician grape fruit, the best qualities of which reached 47s. to 48s. and 44s. to 49s. in September.

South African grape fruit were available in July and August, but did not attain very high prices, ranging between 9s. 6d. and 18s. 9d. with one solitary quotation—the last of the season—of 25s.

Similar fluctuations were noted in the wholesale prices of grape fruit in London as given by a large firm of wholesale fruit merchants.

Isle of Pine grape fruit varied in price between 17s. to 25s. Flórida between 19s. to 30s. 6d. and Jamaican between 12s. and 23s.

(b) *Lemons.*—No wholesale prices are available but as the retail price for good fruit is never less than 2d. and frequently much more this may be taken as varying between 20s. and 30s. per box.

ESTIMATED NETT REVENUE PER ACRE

(a) *Grape Fruit.*—With a wholesale price as low as 10s. per case, a nett profit per acre of £55 would be obtained. Even assuming the yield was only 200 fruits per tree and the wholesale price 10s. per case, a nett profit of £27 would be received. The greatest possible nett profit from an acre of cacao could not exceed £10 per acre, so it is evident grape fruit culture in this country would be a highly remunerative undertaking.

(b) *Lemons.*—The nett profit per acre from lemon trees grown on good soil and in full bearing exceed the figures quoted above and even with a yield less than half that estimated, and double the production costs, a very handsome profit would be available.

INCREASED DEMANDS IN GREAT BRITAIN FOR GRAPE FRUIT

The steady increase in the demand for grape fruit has provided the trade with one of its most interesting features of recent years, and there is every indication that the time is not far distant when grape fruit will rank with apple, orange, banana and grape as being among the most popular fruits handled by our industry. This consistent and increasing demand will undoubtedly be helped by the fact that the grape fruit furnishes yet another instance of a fruit that is available to the trade from one year's end to another, since no sooner is the crop at one source of supply exhausted than the sequence of supply is taken up by some other grape fruit producing area. American grape fruit provides the British market with the bulk of its requirements at present, and it is interesting to note that imports of American grape fruit into the United Kingdom during 1926 amounted to the record figure of 25,939 cases.

The other principal sources of supply are South Africa and British West Indies, and in each of these cases the trade has grown rapidly in the past six years, but the increase in the proportion supplied by the United States has been by far the greatest. Statistics indicate that three-fourths of the grape fruit imports now are supplied by the United States. Some of these imports, however, consist of fruits from the Isle of Pines shipped via New

York. Grape fruit has first appeared as a separate item in the United Kingdom Trade Statistics in 1920, when 21,974 boxes of 70 pounds each were imported. The United States that year supplied 58·3% of the total. British imports in 1927, the last year for which detailed statistics are available, amounted to 606,468 boxes, of which 74·6% was accredited to the United States.

While the bulk of the American exports is shipped during the six months February to July, exports are maintained on a substantial level throughout the year. South African and West Indian supplies in the British Market are, in a sense, complementary to each other. Thus South African grape fruit is available principally from June to September and West Indian supplies largely from December to April.

Although the consumption of grape fruit in Great Britain has grown very rapidly in recent years, the quantities consumed per head of the population are still very small, as indicated by the fact that during the past five years the *per capita* consumption of grape fruit has been only ·2 of a pound.

Imports of Grape Fruit into the United Kingdom

Year	South Africa	British West Indies	Other British Countries	U.S.A.	Other Foreign Countries	Total
1921	2,440	8,770	254	17,923	4,931	34,318
1922	10,216	8,854	—	30,689	800	50,559
1923	12,509	16,877	1,170	45,105	4,418	80,238
1924	15,768	15,787	925	93,689	4,018	130,186
1925	21,837	28,171	787	200,071	17,353	268,186
1926	20,997	43,486	2,688	239,847	25,939	332,956
1927	23,907	47,493	8,926	501,314	24,829	606,468

FACTORS AFFECTING GRAPE FRUIT INDUSTRY

During the past eight years the world's production of grape fruit has increased rapidly and a further large increase may be expected. Taking the import figures into consideration it appears to be inadvisable to carry out further expansion. The production and delivered costs must, however, be taken into consideration. The West Indies cannot land and sell grape fruit in the United Kingdom at less than 30s. 6d. per box, California and Texas 18s. per box, Florida, the Isle of Pines and Porto Rico 16s. per box. Landed costs of Gold Coast fruits should be considerably below any of these figures which places the Gold Coast produce in a distinctly advantageous position. Should the supply at any time exceed the demand the country which can produce good quality fruit at a lower price than any of its competitors is justified in continuing its existng industry or commencing one.

The factor of lower production and landing costs loses its importance unless fruit of good quality and uniformity can be produced since the public will always pay more for a high grade product irrespective of its origin.

There appears to be no reason why the Gold Coast cannot produce fruit equal to that of anywhere in the world. If it can do so, and at the same time keep production and landing costs below that of other countries, it is in a distinctly advantageous position.

THE NITROGEN INDUSTRY AND OUR FOOD SUPPLY*

FOR many centuries nitrogen was used as a fertiliser in the form of farmyard manure, and certain rotations of crops, which kept up the nitrogen in the soil, had been popular; but it was not until 1840, when Liebig first pointed out the true function of nitrogen, potash, and phosphorus, that fertilising became an art based on science. Liebig's work became widely known in a very short time. A little later Lawes and Gilbert started their experiments at Rothamsted, which definitely proved the part taken by nitrogen in agriculture.

From 1840 the use of nitrogen in the form of Chile nitrate steadily increased, and about 1880 sulphate of ammonia became available from by-product coke ovens, and by 1903 the world consumption of these two fertilisers had increased to 1,975,000 tons, equivalent to 351,000 tons of nitrogen.

In 1905 calcium cyanamide was manufactured on a commercial scale for use as a fertiliser, and in the same year the arc process for combining the oxygen and nitrogen of the air to form nitric acid was launched unsuccessfully in Canada. Two years later the arc process was established in Norway and calcium nitrate was put on the market as a fertiliser. Thus Crooke's dream of the commercial production of the nitrogenous fertilisers from the nitrogen of the air was realised in less than ten years. But it was the Haber-Bosch process for the fixation of nitrogen which was to supersede all others and make it possible for us to produce all the nitrogen fertilisers we require now and as far in the future as we can see. In 1906-9 Professor Haber investigated the chemical equilibrium between nitrogen, hydrogen, and ammonia when heated under a pressure over a catalyst. Then Dr. Bosch of the Badish Analin u. Soda Fabrik successfully manufactured ammonia on a large scale by this process in 1913 to 1914.

The fixation of nitrogen in the form of ammonia is so much cheaper than by any other process that this process has very largely replaced the cyanamide and arc processes, and it has shaken the Chile nitrate industry to its foundation—so that the Chilean Government and the nitrate manufacturers have to revise their methods and their processes.

The production of nitrogen in various forms is shown in Fig. 1. The quantities are expressed in tons of nitrogen contained in the products. It will be noticed that the nitrogen industry had already achieved considerable importance in 1898, but it was not until 1921 that the synthetic nitrogen production became greater than the Chilean nitrate production.

NITROGEN FERTILISERS

The world's consumption in 1928 of nitrogen in the form of ammonium sulphate from synthetic ammonia and by-product coke ovens, cyanamide, nitrate of lime, nitro-chalk, and ammonia liquor was 1,442,000 tons and in the form of Chile nitrate 401,000 tons, making a total of 1,843,000 tons, of which 185,000 tons are used in industry and 1,658,000 tons are consumed as fertilisers. If fixed nitrogen is worth £50 a ton—which is about its price in sulphate of ammonia today—then the value of the nitrogen used in fertilising was £83,000,000.

* By Dr. R. E. Slade in *Nature*, No. 3180, Vol. 126, October 11, 1930.

Now, in an acre of typical English arable soil we have in the top nine inches a quantity of humus containing about 2,500 lb. of nitrogen, and at certain times of the year changes take place in the soil making some of this nitrogen into nitrates, in which form it is available for absorption by the plant. The result of this is that in the spring about one per cent. of the nitrogen in the humus is present in the form of nitrate; thus we have present about 25 lb. of nitrogen available for the plant. As this available nitrogen is used up by the plant it is partly replaced by more nitrate being formed from the humus, but during the time of greatest growth there is a considerable depletion of available introgen in the soil. Owing to the continuous breaking down of the humus, the nitrogen absorbed *by the plant is often more than 25 lb.* besides what is washed away by rain. The supply of available nitrogen may be increased by the addition of nitrates or ammonium salts—for the latter are rapidly oxidised to nitrates in the soil.

If we spread one hundredweight of sulphate of ammonia over an acre of ground, this adds 23 lb. of nitrogen to this area, of if we consider the top nine inches of the soil over this area of an acre, we add 1 lb. of nitrogen to each 120,000 lb. of soil. This is such a small amount that we might be doubtful whether it would be sufficient to make any appreciable difference to plants grown on this area. But we have seen that this quantity is of the same order as the quantity of available nitrogen already in the soil.

We will now enquire into the magnitude of the increased yields of crops which can be obtained by the use of nitrogen fertilisers. The figures given in table 1 are average increased yields of various crops obtained on good soil for the addition of each lb. of nitrogen in a fertiliser. They are the averages over many years and many different soils, so that they are increased yields that may be expected for the addition of each lb. of nitrogen—if there is not a deficiency of potash or phosphoric acid in the soil.

Table I

Crop	Increase for 1 lb. Nitrogen	Nitrogen in Crop (per cent.)	Nitrogen Efficiency (per cent.)
	(lb.)		
Wheat (grain)	11·4	1·8	20·4
Barley (grain)	14·2	1·3	18·5
Oats (grain)	12·4	1·6	19·7
Potatoes (tubers)	94·0	0·3	28·2
Swedes (roots)	94·0	0·2	18·8
Mangolds (roots)	150·0	0·2	30·0
Hay	42·3	1·45	61·5

The nitrogen efficiency of the fertilisers in the last column is the percentage *of the nitrogen in fertilisers which appears in whole or part of the* crop described in the first column.

In table II the increased yields are calculated so as to show the increased crop obtained from one hundredweight of sulphate of ammonia in common units.

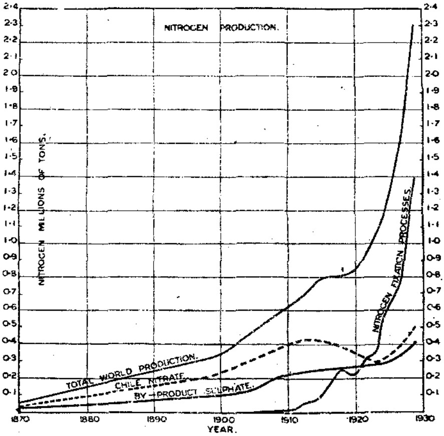

NITROGEN PRODUCTION.
NITROGEN MILLIONS OF TONS.
TOTAL WORLD PRODUCTION.
CHILE NITRATE.
BY-PRODUCT SULPHATE.
NITROGEN FIXATION PROCESSES.
YEAR.
1870
1880
1890
1900
1910
1920
1930

FIG. 1.

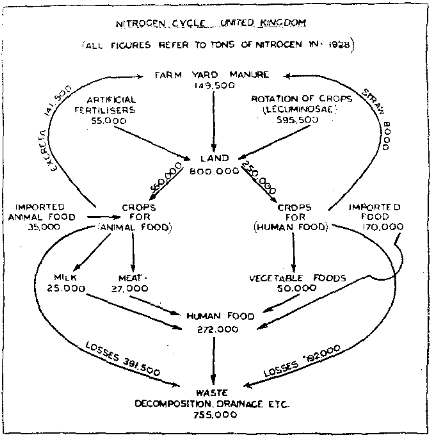

NITROGEN CYCLE UNITED KINGDOM
(ALL FIGURES REFER TO TONS OF NITROGEN IN 1928)
FARM YARD MANURE
149,500
ARTIFICIAL
FERTILISERS
55,000
ROTATION OF CROPS
(LEGUMINOSAE)
595,500
EXCRETA 141,500
STRAW 8000
LAND
800,000
550,000
250,000
IMPORTED
ANIMAL FOOD
35,000
CROPS
FOR
(ANIMAL FOOD)
CROPS
FOR
(HUMAN FOOD)
IMPORTED
FOOD
170,000
MILK
25,000
MEAT
27,000
VEGETABLE FOODS
50,000
HUMAN FOOD
272,000
LOSSES 391,500
LOSSES 192,000
WASTE
DECOMPOSITION, DRAINAGE ETC.
755,000

FIG. 2.

Table II

Crop		Increase for 1 cwt. of Sulphate of Ammonia.
Wheat	...	4·5 bushels or 2·41 cwt.
Barley	...	6·5 ,, ,, 3·02 ,,
Oats	...	7·0 ,, ,, 2·62 ,,
Potatoes	...	20·0 ,,
Swedes	...	20·0 ,,
Mangolds	...	32·0 ,,
Hay	...	9·0 ,,

If we feed grass to a cow giving two gallons of milk a day, we find that 1 lb. of nitrogen causes sufficient extra grass to grow to keep the cow alive one day and to give two gallons of milk. Since two gallons of milk contain 0·8 lb. of proteins or 0·128 lb. of nitrogen, we have 12·8 per cent. of the nitrogen of the fertilisers appearing in the milk, or the efficiency with which the fertiliser is used *via* grass to make milk is 12·8 per cent.

The efficiency of meat production is lower, one pound of nitrogen fertiliser only producing 0·05 lb. of nitrogen in beef, or an efficiency of 5 per cent. on fertiliser.

Summing up these nitrogen efficiencies we have:

Fertiliser to grain	about 20 per cent.
,, ,, potatoes	,, 30 ,, ,,
,, ,, grass or hay	,, 60 ,, ,,
,, ,, milk	,, 12·7 per cent.
,, ,, beef	,, 5 ,, ,, or lower.

It is not surprising that grass shows a higher efficiency than other crops, because the roots cover the ground more completely. I think that the efficiencies on the whole are very high; compare the energy efficiency of a high-class locomotive on the railways, which is not more than 8 per cent.

FOOD PRODUCTION

The food of a man in Great Britain is approximately:

Meat, fish	...	...	14·5 per cent.
Cereals	...	...	18·5 ,, ,,
Milk, cheese, etc.	...	...	24·5 ,, ,,
Potatoes and roots	...	...	25·8 ,, ,,
Sugar, fruit, etc.	...	...	15·5 ,, ,,

—and the nitrogen efficiency in growing these foods from fertilisers is probably about 17 per cent.

The amount of protein consumed per head is 86·5 gm. per day; this contains 14 gm. of nitrogen, so that if this food were grown by using fertilisers at an efficiency of 17 per cent. we should require to use 82 gm. of nitrogen in fertilisers to produce the food for one person for one day; or the fertiliser required to feed one person for a year must contain 365 × 80 gm., or 29 kgm. of nitrogen. One ton of nitrogen in the form of sulphate of ammonia or nitrate of soda will therefore produce enough food for 34 people for one year.

Since the total amount of nitrogen consumed in fertilisers during 1928 was 1,658,000 tons, the amount of extra food produced from this fertiliser would contain enough nitrogen in the form of proteins to support 56,000,000 people; and there would be sufficient carbohydrates and fat associated with this protein to form a complete diet.

Sir Daniel Hall has shown that 2-2½ acres of land are required under cultivation to feed one person. Let us compare this with 1/34 tons of fixed nitrogen. If we assume that the total capital required to build a nitrogen factory is £70-£100 per ton year of nitrogen, inclusive of everything, then for a maximum of £3 invested we can support one person. It would be impossible to bring 2-2½ acres of land under cultivation at so low a capital cost. I do not think that land can usually be settled and cultivated at a less capital cost than £10 per acre, including roads and railways, houses, and agricultural machinery, so that to bring two and a half acres under cultivation would need £25 capital as compared with £3 necessary to produce the fertiliser to produce the same amount of food. I would particularly like to direct attention to this calculation in some countries where governments are always ready to consider and finance schemes to build railways and roads to open up new country or to build irrigation schemes, although the capital to be invested for a given amount of food-producing capacity is often enormous.

STABILITY OF THE NITROGEN FIXATION INDUSTRY

In fixing one ton of nitrogen and making it into fertilisers we use for all purposes about five and a half tons of coal, so that to provide the fertiliser to feed one person for a year we require 3¼ cwt. of coal. The population of the world (excluding China and Turkey) is now about 1940 millions, and 56 millions or 2·8 per cent. are now being fed with food grown by nitrogen fertilisers. Of the nitrogen fertilisers consumed in the year 1928, about 1,000,000 tons of nitrogen was produced by synthesis, needing 5·5 million tons of coal. This quantity of coal is almost negligible when compared with 1500 million tons mined every year. The rest of the nitrogen was produced by by-product coke ovens or as nitrate of soda from Chile.

The population of the world increased by 10 millions each year from 1913-1928. If we had to feed this increase of population by increased nitrogen fertilisation, we should have to build each year a works which would fix 300,000 tons of nitrogen per year and would cost upwards of £30,000,000. In order to run the works we should require 1·6 million tons of coal per year. If we built a works of this size every year for a hundred years, we should then be consuming 160 million tons of coal a year for nitrogen fixation, or only ten per cent. of the coal which is being used in the world today. At least two-thirds of the coal consumed in the fixation of nitrogen is used for power production, so we could reduce the coal required to one-third the value mentioned if other sources of power were available. There are still large areas of the world suitable for cultivation It is therefore improbable that all the food requirements for the growing population of the world will have to be supplied exclusively from nitrogenous fertilisers for some time to come.

DISTRIBUTION OF NITROGEN FERTILISER

Let us now investigate the use which the world makes of the nitrogenous fertilisers available at the present time. I have already mentioned that of the 1,843,000 tons of nitrogen consumed in 1928, 1,658,000 tons or 90 per cent. was used in agriculture.

In table III are shown the quantities of nitrogen consumed in the different countries during the year 1928.

How much atmospheric nitrogen is combined by electric discharges ? How much by bacteria ? How much by our synthetic ammonia processes ? How much humus changes to give nitrate ? How much nitrate is washed away and how much goes into the crop ?

Table III.

	Nitrogen consumed	
	Metric tons, 1928	Lb./Acre Arable
Germany ...	615,200 ...	22·3
France ...	166,900 ...	6·7
Belgium ...	63,600 ...	45·9
Czechoslovakia ...	33,800 ...	5·0
Denmark ...	29,100 ...	9·8
Holland ...	73,400 ...	70·6
Italy ...	68,300 ...	4·7
Poland ...	54,600 ...	2·7
Spain ...	67,300 ...	3·8
Great Britain ...	61,600 ...	10·4
Total (Europe)	1,134,800 ...	—
U. S. A. ...	383,600 ...	2·4
Japan ...	113,300 ...	16·8
Egypt ...	35,900 ...	9·2
Other countries ...	175,600 ...	—
Total (World)	1,843,200 ...	—

What happens to that going into the crop and how much of it forms humus ? What happens to the dissolved nitrogen going down the river into the sea ? How much comes back to land in the form of fish ? Again, how much nitrogen is liberated again from combination ? Is there a dynamic equilibrium in this nitrogen cycle—or are we drifting in one direction ? Are we gaining nitrogen in the air or are we losing it ?

We cannot get answers to these questions. There is no doubt that, in the past, nitrogen was stored up in coal and in Chile nitrate, and this is being liberated now, but we do not know whether nitrogen is being stored up anywhere at the present time. In the diagram, Fig. 2. I have made an estimate of the principal movements in the nitrogen cycle of Great Britain for the year 1928.

The vegetable foodstuffs consumed by man are estimated to contain 50,000 tons of nitrogen. If these are grown with a nitrogen efficiency of 20 per cent. then 250,000 tons of nitrogen is required in the soil. Of this nitrogen it is assumed that 50,000 tons go into vegetable food, 8,000 tons into straw which form farmyard manure, and the rest, 192,000 tons, are washed out of the ground by rain water and lost to the rivers and seas. It will be noticed that I have assumed that the wastage of nitrogen derived from humus is the same as the wastage of nitrogen from artificial fertilisers. I have no direct evidence for this—I have no evidence at all; I cannot think of a more reasonable assumption. I have taken no account of the vegetable and animal life on the moors and mountains except so far as it provides human food. Probably I have neglected some other important factors, but I make no apology for offering this first attempt at a nitrogen flow sheet for Great Britain.

We are now getting much better statistics of agricultural production than formerly, and I believe that consideration of these statistics with other statistics now available has opened up new fields of study in agricultural economics. I have calculated the average amount of nitrogen obtained from

an acre of crops in different countries. The figures in table IV, are for the year 1928. They were obtained by calculating the weight of nitrogen in each crop for each country and then adding up the total amount of nitrogen for each country. This weight of nitrogen is then divided by the area on which the crops grew and we get the weight of nitrogen in the crop in lb. per acre average over the whole country. By crop we mean the portion of the crop taken away for consumption by man or animals : for example, of wheat the grain, of potatoes the tubers etc. The rest of the crop usually goes back to the land and is considered as part of the agricultural system of the country.

Since some crops give a larger yield of nitrogen, in the useful part of the crop, than others, the figures in the table are to some extent affected by the different crops and different proportions of each crop grown in the country. But so far as I can see, the effect of the different crops grown is of only minor importance, and as the production of proteins is the farmer's business, we are not far wrong in considering the first column as an index of the agricultural efficiency of that part of the country under

Table IV

Year 1928	lb. per acre.		
Country	*Total Nitrogen in crops*	*Nitrogen in crops from Artificial Fertilisers*	*Nitrogen in crops from Humus*
Denmark	52·0	2·4	49·6
Holland	49·0	17·6	31·4
Belgium	47·2	11·5	35·7
Great Britain	40·2	2·6	37·6
Japan	34·2	4·2	30·0
Germany	32·5	5·6	26·9
Egypt	31·6	2·3	29·3
France	23·5	1·7	21·8
Canada	21·8	0·1	21·7
U.S.A.	20·8	0·6	20·2
Italy	20·5	1·2	19·3

crops. In the second column is given that part of the nitrogen in the crop which has been supplied by artificial fertilisers. It is assumed that on an average 25 per cent. of the nitrogen supplied to the land as fertiliser is found in the useful portion of the crop. The third column is the difference between the other two columns and is the weight of nitrogen in the crop which has been supplied by the land. In countries with a good system of farming and a good rotation of crops this quantity is high. We see that the system of agriculture in Denmark produces more than twice as much as that in Canada, U.S.A., and Italy, and that in Great Britain we are a little better than Belgium and considerably better than Holland in our agricultural system, apart from the use of artificial nitrogen fertilisers. But since Holland uses seven times and Belgium four times as much nitrogen fertiliser per acre, these two countries obtain greater crops than those obtained in Great Britain, as is shown in the first column.

In Holland one-third of the crops appear to be grown from nitrogen fertilisers. There seems to be no climatic or other physical reason why fertilisers should not be used to a greater extent in Great Britain. If we used as much per acre as in Holland, we should consume 420,000 tons of nitrogen per year; if as much as in Belgium, 272,000 tons; and if as much as in Germany, 132,000 tons. The reason that we de not use more fertilisers does not appear to be economic. The use of sulphate of ammonia yields 100 to 300 per cent. on the money invested within a year. Consider the special case of the fertilisation of wheat. For some years the price of wheat and of sulphate of ammonia has been practically equal. Since 1 cwt. of sulphate of ammonia gives an increased yield of wheat of 2·4 cwt. even after paying for phosphatic and potash fertilisers, one hundred per cent. will be earned on money spent on nitrogen.

Development of the nitrogen fixation industry has lowered the price of nitrogen fertilisers, so that we can expect the needs of the increasing population of the world to be met first by more intensive cultivation of land close to the markets for food rather than by extension of the cultivated area.

MANURIAL EXPERIMENTS ON HEVEA*

IN a previous paper† the results of various manuring experiments on the estates of the Hollandsch Amerikannsche Plantage Mij. were described. One of these experiments there called the "Second Nitrate Manuring Experiments" has been continued and three years' additional results are now available as shown in table 1. The results given by years are discussed below:

Sixth year, March 1924-February 1925.—On March 17th, 1924 the tapping system of the experiment was changed from one-third of the circumference tapped daily to one-half of the circumference tapped in alternate months, the bark consumption being increased from $1\frac{3}{4}$ per month to 2 in. per tapping month. The tapping cut was lengthened by extension in a downward direction. The renewal period remained at 6 years. As will be seen from the yields in table 1, no falling off in yield resulted from this change.

The C. plots received the usual annual applications of 5 lb. sodium nitrate per tree and reached a yield of 535 lb. per acre for the year, the highest reached up to that time.

The B. plots which had been five years without manuring and which as noted in the previous year were showing signs of deterioration again, were used for testing a new nitrogen manure, "Ammophos" applied at the rate of 5 lb. per tree in March. The grade of "Ammophos" used was the 20-20 *i.e.* 20% ammonia and 20% phosphoric acid (P_2O_5). This form of "Ammophos" contains ammonium sulphate as well as ammonium phosphate. Although a slight improvement in the colour of the foliage was discernible no effect in the yield was noted and the results could not compare with the effect of ammonium sulphate.

The E. plots received their normal biennial application of ammonium sulphate, the quantity this year for the first time being reduced to 4 lb. per tree *giving an amount of nitrogen equivalent to 5 lb. of sodium nitrate.*

The D. plots received no treatment.

Seventh year, March 1925-February 1926.—The C. plots annually manured with sodium nitrate again reached a new high record yield of 550 lb. per acre. The control A. plots showed a slight rise of 13 lb. per acre due probably to an average lower tapping cut than the previous year. The deterioration in appearance of these plots continued.

The B. and E. plots were not manured.

* By J. Grantham, *Archief voor de Rubbercultuur,* Jaargang 11, No. 10, October 1927.

† Manurial Experiments on Hevea, *Archief voor de Rubbercultuur,* VIII Jaargang, No. 8, August 1924. (Summary published in *The Tropical Agriculturist,* Vol. LXIII, No. 5, November 1924).

Table I.

Series	Treatment in 1924	1924 March 1 to 15	March 17-April 15	May 17-June 15	July 17-Aug. 15	Sept. 17-Oct. 15	Nov. 17-Dec. 15	1925 Jan. 17-Feb. 15	Total March 1924-Feb. 1925	lb. per acre per year	Kg. per H.A per year
A	Control	32·9 100	112·8 100	223·5 100	300·0 100	276·2 100	307·8 100	278·4 100	1532·5 100	255	286
B	5 lb. 20·20 Ammophos per tree—March	58·8 178·7	203·3 180·2	307·4 137·5	401·3 133·8	363·5 131·8	393·0 127·3	350·8 126·1	2078·1 135·6	346	388
C	5 lb. sodium nitrate per tree—March	115·9 352·3	358·6 317·9	472·1 211·2	588·4 196·1	530·0 191·1	585·2 189·6	561·9 201·8	3212·1 209·8	535	600
D	None	51·5 156·5	169·0 149·8	333·7 149·3	429·8 143·3	393·1 142·3	440·7 142·8	393·2 141·2	2211·0 144·3	368	412
E	4 lb. ammonium sulphate per tree—March	89·1 270·8	294·6 261·1	422·2 180·8	514·2 171·4	479·1 173·4	522·0 169·1	477·9 171·7	2799·0 182·0	466	522

Series	Treatment in 1925	1925 March 17-April 15	May 17-June 15	July 17-Aug. 15	Sept. 17-Oct. 15	Nov. 17-Dec. 15	1926 Jan. 17-Feb. 15	Total March 1925-Feb. 1926	Lb. per acre per year	Kg. per H.A. per year
A	Control	229·0 100	222·8 100	314·1 100	271·7 100	306·3 100	262·6 100	1607·1 100	268	300
B	None	312·6 136·1	319·2 143·3	418·6 133·3	361·2 132·9	372·3 121·5	351·2 133·7	2135·1 132·9	356	398
C	5 lb. nitrate of soda per tree—February	585·9 255·2	516·0 231·6	599·0 190·7	527·0 194·0	540·5 176·5	532·5 202·8	3300·9 205·4	550	616
D	2 lb. ammonium sulphate per tree—February	386·6 168·3	329·4 147·8	435·0 138·5	395·0 145·4	404·8 132·2	402·5 153·3	2353·3 146·4	392	439
E	None	433·2 188·7	425·7 191·0	548·3 174·5	470·5 173·2	493·7 161·2	467·1 177·9	2838·5 176·6	473	530

Series	Treatment in 1926	1926 March 17-April 15	May 17-June 15	July 17-Aug. 15	Sept. 17-Oct. 15	Nov. 17-Dec. 15	1927 Jan. 17-Feb. 15	Total March 1926-Feb. 1927	lb. per acre per year	Kg. per H. A. per year
A	Control	175·6 100	237·5 100	291·2 100	274·7 100	301·0 100	270·4 100	1550·4 100	258	289
B	4 lb. ammonium sulphate per tree—February	272·6 155·2	311·5 131·2	385·2 132·3	360·8 131·3	416·9 138·5	378·6 140·0	2125·6 137·1	354	397
C	5 lb. nitrate of soda per tree—February	463·7 264·1	538·9 226·9	636·0 218·4	571·8 208·2	654·2 217·3	618·4 228·7	3483·0 224·7	580	650
D	None	316·5 180·2	376·4 158·5	433·0 148·7	394·3 143·5	426·7 141·8	406·8 150·4	2353·7 151·8	392	440
E	4 lb. ammonium sulphate per tree—February	390·6 222·4	469·8 197·8	559·2 192·0	510·6 185·9	570·7 189·6	531·6 196·6	3032·5 195·6	505	566

N.B.—All yields given are 1st. latex plus lump only, scrap rubber not being included.

The D. plots previously used for calcium nitrate applications in alternate years, received 2 lb. of ammonium sulphate per tree, *i.e.*, half normal quantity, to be applied in alternate years in future, calcium nitrate beig no longer considered a suitable manure owing to its very hygroscopic nature and destructive action on the skin of the coolies handling it.

No residual effect of the "Ammophos" applied the year previously, appeared in the B plots, the increase in yield being inappreciable.

Eighth year, March 1926-February 1927.—Yet again the annually manured C. plots reached a new high record of 580 lb. per acre and this in spite of an average higher tapping cut, which was expected to cause some falling off in yield. Apparently the limit of increase in yield from nitrogen manuring is not yet reached in these plots.

The control A. plots continued to deteriorate in appearance, severe die-back of the main trunk being quite advanced in a large number of trees particularly in the centre of the plots. From the generally better appearance of the trees on the borders of the plots there is reason to believe that roots passing beneath the isolating drains secure some benefit from the manuring in adjacent plots. The effect is not one of the drains themselves since there are drains through the centres of the plots.

No effect having been shown by the "Ammophos" manuring, the B. series of plots received 4 lb. ammonium sulphate per tree and it is the intention in future to repeat this application annually.

The E. plots received their biennial application of 4 lb. of ammonium sulphate and gave a record yield for this series of 505 lb. per acre for the year.

All plots are now on a permanent manuring scheme which will be continued unmodified for a long period of years as summarised below:

A. Control = unmanured.

B. Annual manuring with ammonium sulphate 4 lb. per tree.

C. Annual manuring with sodium nitrate 5 lb. per tree.

D. Biennial manuring with ammonium sulphate 2 lb. per tree, (half normal quantity).

E. Biennial manuring with ammonium sulphate 4 lb. per tree.

It will of course be a few years before series B. and D. will be comparable with the other series, which have remained unchanged since the beginning of the experiment.

The results so far obtained have been considerably in excess of those originally anticipated and the response of white soil to nitrogen manuring is so favourable as to neutralise the natural superiority of the red ground.

As an example of the realization on a large scale of the increased yields indicated by the experiments it may be mentioned that the yield of the H.A.P.M. over an area exceeding 40,000 acres, of which about 85% is white soil, having reached a standstill at just below 300 lb. per acre in 1920 and commenced to fall back in 1921, showed a steady increase to 474 lb. an acre for the year 1926, following an expanding manurial program on the white soil during the years 1921 and 1923-1926.

Ammonium Sulphate (Time of Application) Experiment Soengei Baleh I.—Ammonium sulphate was applied at fortnightly intervals from the beginning of December 1922 to the end of January 1923, to alternate fields in an area previously unmanured on Soengei Baleh Estate, with the idea of testing to what extent it was possible to apply the manure before the dry season in February, without risk of serious loss by leaching out by the heavy rains. The manure was broadcasted in the usual manner on the surface of the ground.

Alternate fields were treated with 4 lb. of ammonium sulphate per tree as shown in table II.

Table II

Field	Acres	Treatment	Yield in lb. of latex per acre	% Relation to adjoining controls
1 & 3	7·88	Ammonium sulphate—December 9, 1922.	1950	127
2 & 4	7·86	Control = Unmanured	1531	
5 & 7	7·53	Ammonium sulphate—December 17, 1922.	1669	130
6 & 8	8·32	Control = Unmanured	1268	
9 & 11	7·84	Ammonium sulphate—January 2, 1923.	1636	127
10 & 12	8·15	Control = Unmanured	1289	
13 & 15	7·76	Ammonium sulphate—January 17, 1923.	1404	113
14 & 16	8·15	Control = Unmanured	1245	
17	3·88	Ammonium sulphate—February 5, 1923	1393	119
18	4·66	Control = Unmanured	1173	
Total	34·79	Ammonium sulphate	1639	125
Total	37·20	Control = Unmanured	1309	

Equally striking results on appearance (denser dark-green foliage) within 2 to 3 months after wintering were obtained on all manured plots, even those on which heavy rain took place with 48 hours of the period of application. Some retardation of wintering occurred in all manured plots but was most pronounced in the later manured ones.

Records kept of the latex weight of the fields before the experiment started showed the yields to be reasonably uniform. The total yields on alternate month tapping on a half cut from March 1923 (the wintering period for which the application was made) to December 1924 are given in table II.

The experiment is from its nature not a very precise one as regards comparison of yields and no fine distinctions can be drawn between the various times of application, but it will be noted that the average increased yield of all plots over the controls is 25% for the 22 months of the experiment, and that the longest application before wintering, viz. the December 9th. application, gave 27% increase.

The effect of the ammonium sulphate is apparent on all plots and the conclusion is reached, that ammonium sulphate may be supplied a month or two before wintering without appreciable loss, and that the earliest application is at least as good as the latest.

Ammophos Experiment—Soengei Baleh 1.—In addition to the test with "20-20 Ammophos" carried out in the B. plots of the "Second Nitrate Manuring Experiment," a test was also made on a much larger scale in an area of 58 fields previously unmanured on Soengei Baleh Estate, on the opposite side of the road from the Experiment on the time of application of ammonium sulphate just described, 29 alternate fields were manured in the wintering period of March 1924 with 5 lb. per tree of ammophos, the other 29 fields being left unmanured as controls.

A very slight effect in the colour of the foliage was noted about 2 months after the application but as shown in table III, absolutely no effect was produced in the yield in contrast to the much darker colour and increased yields given by the ammonium sulphate on the either side of the road, the previous year.

Table III

Month		Average lb. of latex per acre: 29 manured fields Total 117 acres	Average lb. of latex per acre: 29 manured fields Total 115 acres	Per cent. relationship manured to unmanured
March-April	1924.	75·2	74·6	101
May-June	,,	115·2	116·6	99
July-August	,,	149·8	152·9	98
September-October	,,	119·9	122·1	98
November-December	,,	163·6	160·8	102
January-February	1925.	165·2	169·5	98
March-April	,,	138·8	143·6	97
May-June	,,	114·2	118·7	96
July-August	,,	163·9	168·8	97
September-October	,,	158·8	165·9	96
November-December	,,	143·0	147·4	97
Total	...	1,507·6	1540·9	98

It is not clear why "20-20 Ammophos" should have given no results, while ammonium sulphate on the adjoining land applied the previous year gave quite definite results.

In describing "20-20 Ammophos" the makers state that it differs from the 13-48 grade (which is almost entirely monoammonium phosphate) in being made with sulphuric acid in place of part of the phosphoric acid. An analysis showed a composition approximately equivalent to a mixture containing a molecule of ammonium sulphate $(NH_4)_2SO_4$ to each molecule of monoammonium phosphate $NH_4H_2PO_4$. Two-thirds of the nitrogen therefore appears to be in the form of ammonium sulphate. The 20-20 Ammophos is however more acid ($_pH=4·5$) than the ordinary ammonium sulphate alone ($_pH=5·0$) and possibly this exercises a prejudicial effect as was the case with calcium superphosphate in the D. plots of the "Second Nitrate Experiment" in 1920.

SUMMARY

1. The continued results of manuring with nitrogen fertilizers obtained in an experiment on Soengei Baleh Estate are given for the 6th., 7th., and 8th. years. The plots manured annually in the wintering period with sodium nitrate have reached a yield of 580 lb. per acre or 650 Kg. per H.A. for the year 1926-27 against a yield from the control unmanured plots of only 258 lbs. per acre or 289 Kg. per H.A. The plots manured once in two years with ammonium sulphate have reached a yield of 505 lb. per acre or 566 Kg. per H.A. The tendency of the yield of the manured plots is still upward.
2. It was shown that ammonium sulphate could be applied without loss in effectiveness up to 2 months before the commencement of the wintering period, even where heavy rain occurred soon after the application.
3. No increase in yield was obtained by the use of the fertilizer "Ammophos" grade 20-20 *i.e.* 20% ammonia (NH_3) and 20% phosphoric acid (P_2O_5).

THE SMOKE-HOUSE FOR RUBBER*

"DEVON" TYPE MUCH THE MOST EFFICIENT

A comparison of the relative efficiency of various types of smoke-houses for the curing of rubber has recently been carried out by the Rubber Research Institute of Malaya, and the results are reported by Mr. R. G. Fullerton in the *Quarterly Journal of the Institute* (Vol. II, No. 2). Statistical data was obtained by circulating a *questionnaire* among some fifty estates in various parts of the country. The estates responded by sending particulars of 12 "Devon" smoke-houses, 17 of the "Third Mile" type, and 32 of miscellaneous design.

The mean monthly output of rubber per cubic foot of drying space was found to be: "Devon" type, 6·7 lb.; "Third Mile" type, 3·8 lb.; and Miscellaneous types, 2·9 lb.

It must be pointed out that among those houses classed as miscellaneous are a few giving higher figures for efficiency than the mean value of the "Third Mile" type, although none are higher than the mean value of the "Devon" type. This means that "Devon" houses take precedence over all the others examined, but one is not justified in saying that those of "Third Mile" design are second in order of merit, for the classification of the others under one head does not imply that they all conform to a standard design.

Reasons for "Devon" Type Superiority.—The higher output of "Devon" smoke-houses depends on several factors. In the first place smoke-curing is here a continuous process since the fires are not closed down during the time that freshly machined sheets are being hung in the smoke-house and the dry rubber removed. Any rack may easily be wheeled to the outside verandah for inspection, and for emptying and filling operations, without disturbing the continuity of smoke-curing in the rest of the building, whereas in all other cases the fires must be "damped" or extinguished in order that the coolies may enter the building. The total period of curing for the "Devon" house is therefore less. Again, practically the whole of the drying space is occupied by racks carrying the rubber, and hence a greater weight of drying space than in other cases. Furthermore, the dimensions of the building are such that efficient ventilation is easily attained, for the building is tall, the height being somewhat greater than the length or breadth, no account of course being taken in this consideration of the dimensions of the verandahs, which are external to the house.

Fuel Consumption.—The figures for fuel consumption vary very considerably, the average being 1·6 lb. of fuel per 1 lb. of dry rubber. From the data collected, it was not possible to grade the various types of fire-chambers according to their economy in fuel consumption. In order to obtain fairly comparable results, one would have to test various types of fire-chambers in the same smoke-house working as nearly as possible under the same conditions, and of course no great advantage would accrue from such an experiment, since it is obvious that all that is required of the heating unit is that it shall work with the slowest combustion of the fuel which is consistent with the maintenance of the desired temperature of drying. Slow combustion of the fuel involves the

* From *The India-Rubber Journal*, Vol. LXXX, No. 14, October 1930.

production of more smoke than when combustion is rapid. From this point of view, therefore, one type of fire-chamber is as good as another provided the ventilation is adjusted so as to give the optimum conditions, and this is a matter which must be decided by experience of the operator for the individual smoke-house.

Period of Curing.—The average period of smoke-curing was found to be 10¼ days. Here again there is considerable variation in the figures, and again a large number of factors are responsible. Within the limits of thickness observed (1·8 to 3·7 mm), there is no relation between thickness of the sheet and rate of curing, nor are variations in the depth of colour of the product responsible to any considerable extent.

Among the more important factors responsible for the variation may be mentioned the following:

(a) Ventilation depending on the design of the building.

(b) Temperature of drying—although in the present investigation the limits of temperature reported are practically the same in each case.

(c) Time occupied daily in filling the house with the fresh crop and removing dry rubber.

(d) Closeness of packing of the sheets in the smoke-house.

As regards factor (d) theoretically an increase in the closeness of packing of the sheets in the house tends to increse the period required for drying since the atmosphere inside the building is more moist. However, in practice the closeness of packing is not so great as to affect the rate of drying since the weight of rubber per cubic foot of space is highest for the "Devon" smoke-house, yet the rate of drying is also high. That is to say, the closeness of packing of the sheets would have to be very great indeed in order to produce an appreciable decrease in the rate of drying.

Other Points.—In the majority of cases exit for the damp air and smoke is provided at the top of the building by means of a jack-roof. The walls are of timber and the roof of corrugated iron or tiles. Rubber wood obtained by felling trees in the course of thinning out is the principal fuel employed. To a less extent a mixture of rubber and jungle wood is used. In almost all cases registration of the temperature inside the buiding is obtained by means of a maximum-and-minimum thermometer.

Discussion of Results.—Discussing the results, Mr. Fullerton says it has been made clear that "Devon" type of smoke-house proved to be the most efficient of all those examined. Houses of such design are well known, and are described in detail by Morgan ("The Preparation of Plantation Rubber," by Morgan and Stevens). The special feature of the "Devon" type of building, as has already been pointed out, lies in the provision which is made for wheeling with ease from the drying-chambers any of the racks holding the sheets outside on to a verandah without affecting the continuity of the smoke-curing of the sheets in the rest of the building. There is thus no necessity to stop firing during filling and emptying operations, which may be caried out with ease, ample space being provided on the verandah. The installation may consist of a single house with verandah or of two houses accommodated under one roof with common verandah. It is a system which lends itself very easily to expansion, and is such that it can be used to deal with a crop of almost any size. It may be mentioned that the name merely indicates the design of the house and does not specify the material of the walls or roof, or the type of fire-chamber.

The "Third Mile" smoke-house, consists essentially of a building having two storeys for accommodation of the rubber and a shallow inverted pyramidal base ending on the ground in a fire-chamber, the design of which

is the chief distinguishing mark of this type. The fire-chamber itself is outside the building and consists of an iron cylindrical drums set horizontally in brickwork. At one end of the drum is a hinged door for stoking provided with adjustable air-inlets and at the other end a door for removal of the ash. The drum communicates with the interior of the building by means of a short chimney provided inside with a "damper" adjustable from the outside, and immediately over the chimney is suspended an iron baffle-plate. This system of firing is easy to operate, and provided the doors fit fairly tightly the required amount of ventilation at the foot of the building is obtained by adjustment of the various air-vents.

In what follows is given a summary of features of construction *which should be common to all smoke-houses,* including the special type just discussed. They are considered under appropriate headings.

General Design.—From the point of view of efficiency of ventilation a tall building is to be preferred, the height being greater than either the length or breadth.

The height, however, is limited chiefly by the extent to which it is possible to maintain the required temperature of drying throughout the building and uniform colour of the product. If, for example, the houses were of excessive height rubber in the lower storeys could be maintained at the desired temperature, but that in the upper would probably be far below the optimum conditions. Generally speaking, the number of storeys should not exceed three, the ground floor accommodating the fire-chambers and the upper two storeys containing the sheets.

There is also the question of size of the building. On a large estate, from a consideration of the risk of damage by fire, it is suggested that it is a safer policy to work with a larger number of small units than to accommodate the whole of the crop in one large building.

Ventilation.—The ideal to aim at is the production of a slow current of warm smoke-laden air passing from the bottom to the top of the building. The current should not be too rapid, since in that case the rate of combustion of the fuel will be too great, dust would be raised from the ash formed, and the temperature of drying would be increased beyond the optimum limit. The draught should be just sufficient to carry off the moisture-laden air in the drying chambers.

Since the required degree of ventilation can be obtained only as a result of practical experiment with the invidual smoke-house, there should be sufficient provision for its adjustment. Ordinarily the construction of a smoke-house is not such as to render the lowest storey airtight, air-vents being unintentionally provided, for example, by chinks in the wall and round the edges of the doors. In order to minimise the risk of producing too great a draught, windows should not, therefore, be provided for the ground floor. Air-vents, provided with adjustable doors, which may be made to slide vertically in the apertures, should always be made at the walls. As a guide it may be said that openings are made about 6 inches square at intervals of 4 feet all round the building. If not required, the openings are kept closed, but in the majority of cases adjustment by means of such vents is a necessity. Another factor affecting ventilation at the base is the site of the building. If practicable the house should be situated on fairly level ground so that there is an open space for a considerable distance all round. When the smoke-house has to be placed on a steep gradient earth embankments should be cleared away in the immediate vicinity.

As regards ventilation at the roof, the top of the walls should fit tightly at the eaves of the roof, otherwise a counter current of air will at times be produced in the building. The contraction of a low jack-roof over the main roof ridge provides a very simple and efficient method for the exit of the damp air and smoke. Alternatively chimney ventilators may be constructed, and

if the fitting between the cap and body is sufficiently low interior swinging flaps for adjustment of the openings are not required. A ceiling should be provided protecting the whole of the racks and gangways and of such material that the condensation products of the smoke may be absorbed, thus preventing drops of tarry matter from falling on the sheets. For this purpose the ceiling is best made of wood; sacking would serve the same purpose without, however, being so permanent. One or more central openings in the ceiling, depending on the size of the building, are provided for exit of the damp air and smoke to the roof ridge.

Constructional Materials.—The object in all drying houses is to conserve the heat as much as possible within the building. In this connection it is evident that dIferent considerations enter into the choice of constructional materials in the case of smoke-houses than in the case of crepe drying-sheds. In the latter case there is no internal heating installation, the heat being supplied from an external source by the sun's rays, and hence crepe drying-sheds are constructed of a heat-conducting material such as corrugated iron.

In the case of smoke-houses constructed of corrugated iron, additional benefit it obtained from the heat of the sun during the day, but heat is rapidly dissipated outside the building during the night, when it is more difficult to ensure that the smoke-house attendant is keeping the fires going properly. Moreover the fires alone are capable of maintaining the temperature between desired limits. Hence the use of non-conducting materials such as brick, wood, or asbestos lining is recommended. The choice of constructional materials is of course, regulated largely by questions of economy, and in this connection it may be pointed out that timber soon becomes impregnated with tarry matter, the preservative properties of which confer a very long life on wooden walls, although there is then the risk of damage by fire to be considered. For the material of the roof brick tiles are very satisfactory provided thay are fitted well together so that there is no leakage so that ventilation is confined to the jack-roof or chimney ventilators on the roof ridge. For cleanliness of operation inside the building, the ground floor is best constructed of cement.

Fire-Chambers.—The construction of the fire-chambers must be such as to ensure the lowest combustion of the fuel which is consistent with sufficient smokeproduction and the maintenance of the temperture between the required limits, and it is known that the optimum temperature lies between 110° and 130° F. The choice of a fire-chamber depends, therefore, on the ease with which these conditions can be obtained.

From this point of view probably iron drums or boxes either placed in contact with the ground floor or mounted on a trolley leave least room for errors in ventilation and require least attention in smoking, provided the sides and bottom are almost closed to the air. Special openings near the base are usually unnecessary, and a door for stoking should not be made unless it fits closely round the edges. At the top is fitted a perforated iron plate or a cowl for distribution of the smoke. One or more of these boxes, depending on the size of the house, may be placed at intervals on the ground floor so as to give the most uniform distribution of heat and smoke. Greater freedom from dust in the building may be attained when the boxes are mounted on wheels for removal outside for cleaning and stoking. This type of fire-chamber is suitable for use in a house of any size, and particularly so in the case of small holdings where the building is often of a very temporary nature.

With brickwork ovens, whether stoked from the inside or outside, a hinged door must be fitted for cleaning and stoking, and there is always difficulty in obtaining a closely fitting door. If this can be obtained, however, one or more "butterfly" ventilators should be provided in the door for

provision of the required draught. Nothing elaborate is required for slow combustion fires, and they should be built essentially on the same lines as iron boxes. The hearth may be of clay so as to make the fire-chamber completely closed to the air at the botton. Obviously it is of advantage to arrange for stoking to be done from the outside of the building. Brickwork fire-chambers are, of course, more permanent than iron boxes, but it is doubtful if the additional expense involved is justified except in the case of very large and permanent buildings.

Reference has already been made to the "Third Mile" type, the chief advantage of which lies in the ease with which efficient adjustment of the ventilation may be obtained.

The use of pits sunk in the ground floor as fuel containers is not to be recommended since they provide a small surface for the radiation of heat.

Arrangement of the fire-chamber outside the building, the heat and smoke being distributed to the inside of the house by means of underground flues, is not to be recommended. Such an arrangement is very wasteful, for not only is a considerable amount of heat dissipated during the passage of the hot gases from the fire-chamber to the interior, but a certain amount of tarry matter from the smoke is condensed in the flues and smoke-curing is then much less efficient.

In the majority of cases iron baffle-plates suspended a few feet above the fire-chambers from the first floor are required for uniform distribution of the smoke within the building.

In all cases it is important to note that large fire-chambers are not desirable. The object should be rather to work with a larger number of small units than *vice versa*. Capacious fire-chambers require a bigger charge of fuel and slow combustion is not then easily attained. In small houses it is quite frequent to find that the fire-chamber is much bigger than is warranted by the size of the building.

Lastly, it may be said that the test of slow combustion in any fire-chamber is the nature of the residue after the wood has burnt. The most desirable results are obtained when there is the least ash and most charcoal, provided, of course, that the required temperature has been maintained.

MEETINGS, CONFERENCES, ETC.

COCONUT RESEARCH SCHEME (CEYLON)

BOARD OF MANAGEMENT

MINUTES of the eighth meeting of the Board, held at 11.30 a.m. on Wednesday, October 29, 1930, in the ball-room of the Grand Oriental Hotel, Colombo.

Present.—The Hon'ble Dr. Youngman, (in the chair), Mr. C. W. Bickmore, C.C.S., the Hon'ble Sir H. Marcus Fernando, the Hon'ble Mr. A. Mahadeva, Mr. N. R. Outschoorn, Mr. John A. Perera, J.P., U.P.M., the Hon'ble Mr. D. S. Senanayake, Mr. J. I. Gnanamuttu (Secretary).

Minutes.—The minutes of the meeting held on September 3, 1930, copies of which had been circulated to members, were taken as read and were confirmed and signed by the Chairman.

Provident Fund.—Mr. Bickmore stated that the Board's technical staff could not come under the proposed Public Officers Provident Fund Ordinance but that the Post Office Savings Bank certificates which might furnish a basis of a Provident Fund were expected to issue shortly. Mr. Bickmore consented to formulate a Provident Fund Scheme for the Board's employees.

Finance.—(a) The statement of receipts and expenditure for the quarter ended September 30, 1930, copies of which had been circulated, showed a credit balance at that date of Rs. 105,571·05, of which Rs. 80,000 was on fixed deposit. The statement was passed without comments.

(b) The draft estimates of income and expenditure for the year 1931, copies of which had been circulated to members, were considered in detail.

CAPITAL ACCOUNT

B.—*Acquiring and clearing jungle area for nursery work.*—The Chairman stated that, as Bandirippuwa was a fully developed estate any part of which it would be unwise to clear, experiments with selected nuts should be carried out on other land and that the Director of Research had suggested the acquisition of Crown jungle land to be cleared for the purpose. He thought that land wihin 10 miles of Bandirippuwa would be suitable. Sir Marcus Fernando enquired whether the Wariapola farm would not be suitable. The Chairman was not certain of the future of the Wariapola station and feared also that the extensive travelling between Bandirippuwa and Wariapola had to be considered. Although there was no objection to using Wariapola, he advised that for the present it would be preferable not to enter upon a programme of work there by the Board. The sum against this sub-head was increased from Rs. 1,500 to Rs. 5,000.

C.—*One senior staff bungalow.*—After discussion, it was agreed that the provision of Rs. 27,000 should be regarded as the limit of expenditure under this sub-head.

D.—*Two junior staff bungolows.*—The provision of Rs. 40,000 for bungalows for the Technological Chemist and the Geneticist was passed subject to details being furnished.

E.—*Four bungalows for scientific assistants and clerk.*—In passing a sum of Rs. 24,000 for quarters for three scientific assistants and one clerk, it was desired that the possibility of constructing two blocks of semi-detached quarters should be explored. Mr. Bickmore stated that in the experience of the Public Works Department this method resulted in no saving where the site value was not considerable.

F.—*Lines for menial staff.*—It was understood that the cooly lines proposed were for the menial staff and that the estate labour would be largely drawn from the resident village population. The provision of Rs. 1,200 was increased to Rs. 3,000 to allow ot six quarters being built.

G.—*Laboratory structures.*—More details were desired of these. The rooms as indicated in the plan submitted by the Director of Research were considered to be too small. It was considered that as a tentative estimate the total cost might be Rs. 50,000, of which Rs. 30,000 was authorised to be spent in 1931.

H.—It was decided to vote Rs. 12,500 on account of equipment of Laboratory, including gas, electricity and water supply.

K.—It was decided to allot Rs. 5,000 under furniture for three staff bungalows subject to a list of the heavy furniture to be supplied first receiving the sanction of the Board.

A total expenditure of Rs. 340,056 was voted under Capital Expenditure, against receipts amounting to Rs. 350,000 (instalment of Rs. 150,000 out of the Government loan of Rs. 200,000, plus the Government Grant of Rs. 200,000.)

INCOME

Mr. Mahadeva pointed out that an expenditure in excess of the estimated income had been budgeted for. The Chairman explained that a surplus of income over expenditure amounting to Rs. 109,500 was expected at the end of December, 1930. Sir Marcus Fernando was of opinion that the Cess collections for 1931 had been underestimated, seeing that the coconut produce of the Island was bound to be exported in the usual way and that the exports might increase in 1931 as a result of the better weather conditions in the current year. It was agreed that the probable income from Cess collections should be fixed at Rs. 49,000, similar to that of 1930. The estimated total receipts would thus amount to Rs. 97,500, to meet a recurrent expenditure totaling Rs. 96,205.

By order,

J. I. GNANAMUTTU,

Secretary,

Coconut Research Scheme.

DEPARTMENTAL NOTES

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA

FOR THE MONTHS OF SEPTEMBER AND OCTOBER, 1930

PLANS FOR THE REORGANISATION OF THE WORK OF THE STATION

The following provisional decisions have been made regarding the future work of the station:

(1) That the present trial of *Indigofera endecaphylla* in tea shall be continued till the end of September, 1931, and that thereafter the tea area shall be divided into two fields and plucked on commercial lines as a revenue-producing concern and for demonstration to the students of the Farm School.

Shade trees are to be planted in those plots where there are none at present. The unplanted strips dividing the present plots are to be planted up with tea.

(2) The following rubber experiments are to be continued for the periods specified:

(a) Right and Left cuts, till March 31st 1931.

(b) Change-over experiment, till its termination on March 31st, 1932.

(c) One-third resting experiment, probably till March 31st, 1932.

(d) Rejuvenation experiment, till August 31st, 1931, with the option of continuing till August 31st, 1932, if thought desirable. It is to be noted that the idea of replanting rubber in this area has been abandoned so that the experiment has virtually become a tapping to death experiment.

(e) New Avenue Rubber Manurial Experiment, until definite conclusions can be arrived at.

(f) Height of tapping on budded rubber experiment, as long as thought desirable.

(g) Experiment on influence of stock on scion, indefinitely, until results can be determined.

(h) Forking in of Vigna experiment. This experiment is suspended for a year to allow the re-establishment of an even growth of Vigna. It may or may not be resumed in modified form on April 1st, 1931.

(i) Two *vs.* three-day-tapping trial, and comparison of V cut with single cut in Hill top rubber, until December 31st, 1930.

(j) Comparison of continuous alternate day tapping with daily tapping in alternate months in the Hillside rubber until December 31st, 1930.

The above plans will free the whole of the central rubber block comprising Plots 77 to 87 and the Avenue Rubber by the end of 1932; it is proposed to eradicate the rubber and convert the area into a cattle-grazing paddock, leaving a few trees for shade. Certain portions of this area are already free and the eradication of the trees in these portions will be started as soon as a satisfactory contract can be arranged.

Plots 151 to 154 are now being tapped for a year with normal tapping prior to initiating a fresh tapping to death experiment. It has been decided that the tapping to death experiment shall be continued for 6 months only from April 1st, 1931, and that this rubber shall be eradicated after October 1st, 1931.

The above plans will entail a reduction of the area under rubber by the end of 1932 from 58¾ acres to 38¼ acres. The rubber that is left, apart from areas used for experiments detailed above, is to be tapped on commercial lines and used for demonstrations to the students of the Farm School.

(3) Two main lines of activity in cacao have been decided upon :

(a) The recording of individual yields of apparently high-yielding trees followed by propagation from such trees by budding, and the testing of the progeny of such trees on a field scale. Nine large cacao estates have been asked to co-operate in this work.

(b) An intensive campaign against diseases and pests in one block of cacao with the object of noting whether the cost of such treatment is justified by the value of the increase of crop over the other blocks where the present routine operations are to continue.

(4) It has been decided to undertake an investigation into the possibilities of increasing yields of robusta coffees by grafting from heavy bearing bushes. For this purpose 48 trees on the station have been selected and individual yield records have been kept since October 1st, 1930.

(5) It has been decided to undertake citrus cultivation on a large scale and it is proposed eventually to utilise plots 151-154 (rubber to be uprooted in 1931) and plot 155 (tea uprooted), with possible inclusion of plot 140A (rubber), and an area of waste land adjoining this plot.

(6) It has been decided to start selective breeding work with local black cattle to be eventually accommodated in the rubber area to be eradicated.

TEA

All vacancies in plots 141-149, 166, and the Half-Acre tea were supplied in August and failures were re-supplied twice in September and once in October.

A census of bushes in bearing was taken for record purposes in the plots under *Indigofera* trial.

RUBBER

The Change-over Experiment

This experiment was started on April 1st, 1926. 384 trees are utilized and these are divided into twenty-four plots of sixteen trees each. In eight of these plots the cut is changed over every six months, in eight plots once a year, while in the remaining eight plots no change-over is made until the panel is completed at the end of three years. Since during the course of the experiment the cuts are of necessity at different heights from the ground. No true comparison of yields can be made until both panels are completed at the end of six years. In the meantime bark renewal measurements are taken every two years and the second measurement was completed on October 1st, 1930.

It is not easy to devise an entirely satisfactory system of comparative measurement of bark renewal in an experiment of this kind. It is obvious that bark must be of the same age when measured but beyond this there are the alternatives of making all measurements at the same time, irrespective of the height on the tree at which the measurement must be made, or of

making the measurements at different times but at the same heights from the ground. The experiment was planned in collaboration with an officer of the Rubber Research Scheme who favoured the latter alternative on the ground that the thickness of bark increased in the lower portions of the tree. This officer's views were eventually adopted and measurements were made at different times but at the same height from the ground. The figures given below, however, suggest that there is a possibility that the fact that different periods, and therefore different sets of climatic conditions, intervene between two measurements in the different sets of plots may affect the issue. Thus, in the 1928 measurements the average thickness of the renewed cortex in the change-over-twice-yearly plots was larger than that of the other two sets, while in the 1930 measurements it is the smallest of the three.

It is possible that the comparative failure of the 1930 south-west monsoon may have influenced the rate of growth of renewed bark. As, however, the final standard of comparison must be the relative percentage between the thickness of renewed bark and of untapped bark, and as these figures are in the same order in both measurements, the point is perhaps of not such importance. The following are the results of the two measurements:

Measurements of Renewed Bark and Untapped Bark in Change-over Experiment

	Thickness of renewed cortex in m.m.		Thickness of untapped cortex in m.m.		Thickness of renewed cortex expressed as percentage of untapped cortex.	
	1928	1930	1928	1930	1928	1930
Average of no change-over plots	4·75	5·79	6·96	8·34	68·2	69·4
,, ,, change-over yearly ,,	4·37	5·64	6·77	8·80	64·5	64·5
,, ,, ,, ,, twice ,, ,,	5·44	4·88	9·18	9·08	59·2	53·7

It is to be noted that in 1930 average thickness of untapped bark in the change-over-twice-yearly plots comes out slightly lower than in 1928. It is not of course suggested that the average thickness of untapped bark has actually decreased but it is not possible to take the measurements in exactly the same place on each occasion and it is supposed that chance differences caused by unevenness in the bark must have brought about the result. It is to be noted that concurrently with this lack of increase in thickness in renewed bark there is a marked drop in the thickness of renewed bark in these plots compared with the 1928 figures, both actual and relative to the averages of the other sets of plots. It cannot be definitely stated that this is due to the system of changing over and final conclusions must await the 1932 measurements and yield figures; but from the interim results the experiment affords no support to the widely held opinion that changing over the cut results in better bark renewal.

The Rejuvenation Experiment

Allusion to this experiment has already been made (1) in an article entitled "Tapping to death: a Warning" which appeared in *The Tropical Agriculturist* for April, 1930, and (2) the progress report of this station for May and June, 1930.

In both publications stress was laid on the large number of cuts which had gone dry after a few months as a result, it is believed, of continuous daily tapping. The following table shows the situation at the end of a year of tapping:

	Number of trees	Total number of cuts put on	Number of cuts gone dry	Percentage of total number of cuts gone dry	Yield of dry rubber per tree for the year		Calculated yield of dry rubber per tree from previous year	
					lb.	oz.	lb.	oz.
Plot 1.—Tapped daily to the wood on two cuts on half circumference. *Bark consumption 2 ins.* per month, to be tapped for 1 year.	68	192	79	41	13	15	6	7
Plot 2.—Tapped daily to the wood on two cuts on *the half circumference.* Bark consumption 1⅜ in. per month, to be tapped *for 3 years.*	76	206	69	33	14	7	8	8
Plot 3.—Tapped daily to *the wood on two cuts on* the half circumference. Bark consumption $1\frac{1}{12}$ in. per month to be tapped for 3 years.	43	121	43	35	18	6	8	4
Plot 4.—Tapped daily in alternative days on two cuts on the half circumference. Fine tapping but not to the wood. To be tapped for 4 years.	40	82	2	2	14	8	8	7

The figures in the last column are based on Mr. Lord's computation made when the experiment was started, of the previous year's yield from 8 months' tapping on ⅓ circumference. They are therefore empirical and only afford a rough comparison. It would appear that the yields obtained by intensive tapping are generally rather less than double the calculated of the previous year. It is to be noted that the yield of plot 4 is the second largest although it has received only half the number of tappings given to the other three plots. There are two possible explanations for the freedom from drying up of cuts and consequent comparatively high yield in plot 4.

(1) The fact that it is tapped daily in alternate months instead of continuous daily.

(2) The fact that it is not tapped to the wood.

101 trees in plot 13 were on a previous occasion tapped to the wood for a year. A general increase in yield of approximately 25% occurred and the incidence of brown bast was negligible. For this reason the writer is strongly of the opinion that the continuous daily tapping is the factor responsible for the drying up of cuts. It is intended to test this out in the experiment to be initiated next year in plots 151-154.

The tapping of plots 2, 3 and 4 is being continued, while most of the trees in plot 1 have been marked for eradication.

Brown Bast

A complete round of brown bast treatment was finished in August.

CACAO

In preparation for the cacao selection work outlined above a number of trees have been selected for yield recording and a nursery has been laid down to serve as stocks for future budding operations.

Helopeltis in cacao has been observed to be worse than usual.

A study of the viability of pollen from a barren tree and from a heavy yielding tree was completed in September by Mr. J. C. Haigh, Assistant Mycologist, whose report is given below.

"Germination tests have been carried out with pollen from a sterile cacao tree at the Experiment Station, Peradeniya. The tree bears abundant flowers but has never been known to set a pod. Comparative tests were carried out at the same time with pollen from a tree (No. 5. "B" cacao) that in the last three series of yearly records has produced respectively 119, 108 and 105 pods.

"The flower of *Theobroma cacao* opens in the early morning; advantage was taken of this fact to ensure that only fresh pollen was used for the tests. In the evening all opened flowers were removed from one branch of each of the trees under examination, thereby assuring that the flowers picked for experiment next morning were newly opened. The flowers were picked in the early morning and the pollen from them was sown on 1·5% agar in petri dishes. Five flowers were taken from each tree per day and the pollen from each anther was sown separately; twenty-five pollen masses per tree per day were thus obtained. Normal pollen germinates in a few hours in a moist atmosphere, but for convenience the pollen was examined twenty-four hours after sowing. Germinative power was judged by the percentage of pollen grains that had produced a germ tube. From the good tree 4,664 pollen grains were examined, of which 3,379, or 72·4%, had produced a germ tube in twenty-four hours; from the sterile tree 4,191 pollen grains were examined, of which only 15, or 0·36%, had germinated in the same length of time. Samples of pollen from the sterile tree were kept for five days, but no increase in germination percentage was observed. Pollen from the good tree was seen to germinate a few hours after sowing. The only observable difference between the pollen from the two trees was that that from the sterile tree contained a small percentage of larger, thin-walled grains. The normal pollen grain examined was about 20 microns in diameter and had a thick wall; the larger grains had a thin wall and were about 30 microns in diameter.

"The above tests show that the failure of the pollen of the sterile tree to germinate is a factor responsible for the sterility of the tree, since self-fertilisation is impossible. It is generally held that the cacao flower is in the main self-fertilised, but Harland has shown that cross-fertilisation occurs in cacao; it is still necessary, therefore, in accounting for the complete sterility of this tree, to explain the failure of cross-pollination. A detailed investigation will probably be necessary before this explanation is found; in the meantime a few simple hand pollinations have been made, using pollen from the good tree of the germination tests. It is perhaps of interest to note that similar tests carried out in the West Indies failed to show a significant difference in germinative power between pollen from good and poor yielders, and that in such trees, which were incidentally the progeny of the same parent, sterility was due to a defect in the female part of the flower."

COFFEE

The coffee year ended on September 30th. The following are the yields of fresh berries per bush for the last seven years:

Pounds fresh berries per bush

Robusta Types

Year	Robusta	Uganda	Quillou	Canephora	Hybrid
1923-24	2·37	3·43	6·91	3·01	8·38
1924-25	4·01	5·29	3·43	3·88	5·62
1925-26	3·23	2·06	8·91	3·09	9·78
1926-27	8·54	8·99	5·01	10·29	7·61
1927-28	5·57	6·86	13·45	7·63	8·26
1928-29	7·44	6·69	6·18	8·55	5·19
1929-30	7·58	7·82	5·94	8·38	7·82
Average	5·53	5·88	6·40	6·40	7·52

Liberian Types

Year	Excelsa	Abeokuta	Liberia Pasir Pogor	Klainii	Arnol-diana
1923-24	5·56	9·16	6·68	—	—
1924-25	19·82	12·84	13·84	—	—
1925-26	14·00	15·26	11·71	—	—
1926-27	25·80	18·94	21·21	—	—
1927-28	19·75	17·77	12·76	6·54	2·00
1928-29	22·00	31·20	27·16	2·54	2·50
1929-30	26·16	32·28	29·69	10·14	3·50
Average	19·01	19·63	17·51	6·40	2·66

Arabian Types

Year	Arabica (Plot 140 *I*)	Kent's	Jackson's Hybrid
1923-24	2·39	—	—
1924-25	2·39	·64	·18
1925-26	2·00	1·36	1·39
1926-27	3·26	·21	·58
1927-28	1·25	·69	·15
1928-29	1·93	1·84	·76
1929-30	1·20	·67	·63
Average	2·06	·89	·61

The yields of the Robusta types are well up to the average and a steady sale of seed and plants of these coffees continues. The yields of the Liberian types are high, but the berries contain a larger proportion of pulp and the produce fetches locally only about half the price of Robusta.

The yields of the Arabian types are as usual low and the bushes are in a very poor condition.

A round of pruning was completed early in September.

Considerable trouble has been experienced with red ants which abound in the coffee plots of the Economic Collection and have formed numerous nests. Spraying with kerosene emulsion, even at double the normal strength, proved ineffective.

Forty-eight bushes were selected for recording of individual yields.

FRUIT

A small amount of budwood was taken from the young grape fruit trees imported from South Africa in 1928, and the buds were put on to Pumelo stocks. The results were as follows:

Variety	Number of buds put on	Number of successes	Percentage
Cecily seedless	17	6	35·3
Ellen	28	10	35·7
Foster	30	17	56·6
Triumph	34	22	64·7
Marsh's seedless	37	27	72·9
Walters	30	20	66·6

The buds of Cecily seedless peeled badly and many were damaged. This is the first citrus budding done on the station and an improvement may be expected.

In addition budding was done from a number of sticks of budwood received from South Africa, but little success can be anticipated from this budding.

The regular spraying of citrus trees of value is to be undertaken under the supervision of the Mycologist as soon as supplies of "Sulfinette" arrive.

OIL BEARING TREES

The replacement of *Hydnocarpus whightiana* trees in block A of the terraced valley by *Taraktogenus kurzii* was carried out with the first north-east rains. All these plants are growing.

In block B 36 plants of *Aleurites montana* were put in to replace *Hydnocarpus whightiana* and 35 of these are growing well. This block was also extended and holes dug to receive additional plants of *Aleurites montana* when the seed of a mature tree near the store ripens.

The new arrangement of the area is as under:

Block	A.	Taraktogenus kurzii (Chaulmoogra oil)	75 trees.
Block	B.	Aleurites montana (Tung oil)	36 ,,
Block	C.	Taraktogenus kurzii (Chaulmoogra oil)	177 ,,

Illuk was forked out of this area in October and the cheddy cut back from the edges of the terraces.

A system of paths and steps was also completed, giving easy access to all the terraces.

FIBRES

The sunn hemp trial under old coconuts and in the open mentioned in the last report was abandoned. In the former case germination was very poor and the plants all flowered at a height of about 2 feet. In the latter case germination was excellent but all the plants flowered at a height of 12 to 18 inches. The crop was ploughed in.

MISCELLANEOUS

All the sugar canes were dug out of the plots 18 D, 19 D and 20 D. Out of the nine varieties growing in those plots six have been replanted in the annual economic area. An order for sugar cane sets is a very rare occurrence.

A round of forking couch and illuk was completed by the end of October. This is the first round for which it has been possible to spare labour this year. It is feared that with the reduction in the labour force rendered necessary by the curtailment of the allocation this year the position in regard to these serious weeds is bound to deteriorate.

The following are the figures for revenue and expenditure (exclusive of monthly salaries) for the last seven years:

Year	Revenue Rs. Cts.	Expenditure Rs. Cts.
1923-24	19,904·14	31,400·81
1924-25	33,546·44	32,446·08
1925-26	29,731·13	33,091·59
1926-27	33,775·61	35,061·58
1927-28	29,204·98	37,820·95
1928-29	24,284·77	40,234·37
1929-30	20,165·44	40,998·73

The fall in revenue in the last two years is due to the decline in prices of the staple products, while the increase in expenditure is due to (1) increase in wages to bring these into conformity with the provisions of the Standard Wage Ordinance; (2) increase of the cultivated acreage of the station.

THE IRIYAGAMA DIVISION

The period under review has been one of great activity. All budding in the field in areas 1 and 2 and budding in the nursery for area 2 was completed. By the end of October most of the buds on the nursery plants had started to shoot and the stumps had been planted out in the field. Weather conditions were fortunately ideal—the north-east rains started just when the first buds started to shoot and good planting weather continued for some time.

Failures in areas 1 and 3 were rebudded on the other side of the stocks and a high percentage of successes was obtained from this rebudding. Final failures were replaced by reserve stumps budded for this purpose in the nursery. There are excellent prospects of getting a good even stand in these three areas. The full results of the above budding have been incorporated in an article for *The Tropical Agriculturist*. The article contains all percentages of successes and other figures which will therefore not be repeated here.

A further area, to be known as area 7, has been terraced and laid out for the reception of foreign clones. The area will contain plots of the following:

Ct 88
AVROS 256
P and T 11
P. B. 23
H 2
Seedlings

The necessary budding in connection with this area was done in the nursery in September and the plants will be put out when the buds shoot. Budded stumps of AVROS 256 are expected to arrive early in November.

In addition to this budding the budwood of certain mother trees which was insufficient to establish a clone of 60 trees this year was multiplied in the nursery.

There is a prospect of being able to establish another area of 10 clones next year, but after that no further mother trees are at present in sight and a good deal of opened land is likely to lie idle for a considerable time.

In addition to budding and connected operations the labour force has been employed in uprooting stumps and building stone steps.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st DECEMBER, 1930

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1930	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	1283	54	238	855	20	170
	Foot-and-mouth disease	264	2	254	10	...	...
	Anthrax	...	...	...	...	...	...
	Piroplasmosis	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Colombo Municipality	Rinderpest		...	...	...	...	...
	Foot-and-mouth disease	448	1	434	12	1	1
	Anthrax	37	6	...	37	...	...
	Haemorrhagic Septicaemia	6	...	...	6	...	...
	Black Quarter	2	...	...	2	...	...
	Bovine Tuberculosis	1	...	...	1	...	...
	Rabies (Dogs)	12	1	...	...	...	12
Cattle Quarantine Station	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax (Sheep and Goats)	704 *	35	...	704	...	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	660	10	658	2	...	...
	Anthrax (Sheep)	1	...	...	1	...	...
	Piroplasmosis	4	...	1	3	...	...
	Rabies (Dogs)	12	...	...	10	...	2
Southern	Rinderpest	351	29	86	261	4	...
	Foot-and-mouth disease	269	...	263	6	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	3	...	...	2	...	1
Northern	Rinderpest	4	...	3	1	...	...
	Foot-and-mouth disease	2975	...	2905	70	...	...
	Anthrax	...	...	...	...	...	...
	Black Quarter	224	...	...	224	...	...
	Rabies (Dogs)	3	...	...	...	...	3
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	100	...	98	2	...	...
	Anthrax	...	...	...	...	...	...
North-Western	Rinderpest	8195	1400	459	6782	13	941
	Foot-and-mouth disease	135	...	135	...	...	...
	Anthrax	...	...	...	...	...	...
	Pleuro-Pneumonia (in Goats)	50	...	...	50	...	...
North-Central	Rinderpest	1930	594	115	1681	24	110
	Foot-and-mouth disease	1069	...	1045	24	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	72	...	72	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	3	...	...	...	...	3
Sabaragamuwa	Rinderpest	63	...	7	54	...	2
	Foot-and-mouth disease	1445	...	1440	5	...	...
	Anthrax	...	...	...	...	...	...
	Haemorrhagic Septicaemia	85	16	...	85	...	...
	Rabies (Dogs)	14 †	...	...	4	...	10

* 1 case in a buffalo—Rest sheep and goats. † 1 case—a calf.

G. V. S. Office,
Colombo, 10th January, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

DECEMBER, 1930

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo -	86·8	+1·5	72·5	+0·6	70	90	5·0	0·27	3	− 5·17
Puttalam -	85·[illegible]	+1·8	70·6	+0·1	74	93	4·1	1·76	6	− 4·42
Mannar -	85·1	+2·6	75·5	+1·1	72	84	4·6	1·00	6	− 6·70
Jaffna -	83·5	+2·0	71·6	−1·4	74	95	5·4	0·98	6	− 9·33
Trincomalee -	81·6	+0·2	75·5	+1·4	77	84	4·8	2·22	9	−11·69
Batticaloa -	82·9	+1·2	73·0	+0·1	78	93	6·4	5·47	13	−11·08
Hambantota -	84·9	+0·5	72·3	−0·4	74	90	4·0	5·62	7	+ 0·28
Galle -	84·[illegible]	+1·0	73·3	+0·5	76	93	5·4	1·00	8	− 5·74
Ratnapura -	89·8	+3·7	71·8	−0·4	68	93	4·2	4·69	12	− 4·24
A'pura -	85·5	+2·7	68·2	−1·9	72	95	4·2	3·77	5	− 4·82
Kurunegala -	87·3	+1·6	70·9	+0·2	68	90	5·8	2·71	6	− 4·31
Kandy -	84·[illegible]	+2·7	66·8	−0·3	68	92	5·2	1·92	7	− 6·97
Badulla -	77·1	+0·6	63·5	−0·9	78	94	5·5	1·35	9	−10·88
Divatalawa -	73·3	+2·1	57·0	−1·5	76	91	5·7	1·03	9	− 6·89
Hakgala -	69·3	+2·4	50·7	−2·1	80	87	4·5	1·41	11	−12·05
N'Eliya -	70·1	+3·9	44·6	−3·6	68	93	4·4	1·82	9	− 6·56

At about half the stations in Ceylon the total rainfall in December 1930, was lower than in the December of any previous year, while out of over *360 stations less than half a dozen recorded as much as their previous* average. The biggest deficits were in the Rangalla district, where several were of the order of 30 inches.

Rain was particularly deficient during the week from the 15th-22nd, which coincided with the appearance of a mild depression in the Bay of Bengal, too far east to give rain in Ceylon. A depressional menace on the 23rd was responsible for six inches of rain at Topawewa on that day, but did not materialise further. The only other station to report over *5 inches in a day was Yataderiya with 7·70 inches on the 27th.* The highest total was at Morawaka (19·86) which was the only station to record more than 15 inches. It is noteworthy that despite the general drought no stations failed to report any rain at all.

As the natural concomitant of the low rainfall the number of hours of bright sunshine was above average and the humidity and amount of cloud deficient. This latter resulted in the day temperatures being above average in all cases and the night ones being either below average, or less above *average than the day temperatures were (Trincomalee alone was an exception to this).* At Nuwara Eliya the night temperature in air got down to freezing point four times (19th-22nd) on which days the surface temperature went below 30°F.

Pressure was consistently high, and the direction of the gradient roughly from N.W. instead of the normal December direction which is from between N.N.W. and North.

A. J. BAMFORD,
Superintendent, Observatory.

The

Tropical Agriculturist

February 1930

EDITORIAL

CEYLON'S SPICE TRADE

A survey of the production of spices in the Island is at the present time being undertaken with the idea of seeing what this production is, what opportunities there may be of improvement and increase in the industry, and what it is possible to do by supplying periodical information upon the condition of the various crops with regard to quantity and quality. The last information has been especially asked for by the spice industry itself.

Ceylon's export trade in spices is of the value of some ten million rupees annually. When a study of the import spice trade is made the most striking fact is the large sum annually sent out of the Island for commodities that could in many cases be produced at home. Especially prominent amongst such articles are spices used in the preparation of curries for the home production of which one would expect a natural incentive. Upon such imports Ceylon spends annually over five million rupees most of which is upon chillies, turmeric, cumin and coriander seeds.

The value of the export industry is in the main made up by the two commodities cinnamon and arecanut. Cinnamon in the form of bark, chips, or, oil distilled from any part of the shrub, usually the leaves, brings in some four and a half million rupees. The cultivation of cinnamon in the Island is an ancient one. Prices in the past year fell lower than they have been for nine years. The industry at present presents, unfortunately, a somewhat uncertain outlook. The chief markets in order of importance are South America, Spain, the United States of America, Germany, and the United Kingdom.

Arecanuts, the favourite masticatory stimulant of our Indian neighbours, bring in some three million rupees yearly, and the demand is an increasing one. Export elsewhere than to India is insignificant. Almost half of these nuts would seem to come from the Sabaragamuwa Province. One point in Ceylon's favour in the production of arecanuts is that in the major part of the consuming country this crop will not grow. The areca palm is slow to bear, but the crop is a profitable one, and might perhaps with advantage be more generally planted.

Cardamoms to the value of some three quarters of a million rupees are annually exported. The greater part of the trade is with Europe but Japan has recently been increasing her takings. The cardamom plant belongs to the same family as does the ginger plant. There are different varieties of cardamoms, the produce of which is differently graded and valued by the purchasers. There are false cardamoms too derived from a totally different genus of plants.

The export of black pepper last year was over five thousand hundredweights valued at over a quarter of a million rupees. This crop should be capable of considerable expansion in the Island. Pepper vines can be planted in the shade at the foot of many trees and they begin to bear in their third year and may continue to do so for twenty-five years or more.

A small annual export trade is also done in nutmegs, mace and cloves. Our trade in nutmegs would seem to be with India. Ceylon's nutmeg trade is of small value but it again could be increased, the fact that the tree is slow to bear, however, is somewhat against it as a crop.

A NOTE ON THE DESTRUCTION OF THE NESTS OF MOUND-BUILDING TERMITES

F. P. JEPSON, M.A.,
ASSISTANT ENTOMOLOGIST

THE mounds formed by certain termites, often attaining a height of several feet, are a characteristic feature of the landscape in most parts of Ceylon below an elevation of 4,000 feet. They consist of earth removed by the workers in the course of their subterranean excavations and the particles of earth are cemented together with salivary and anal discharges to form a composition which is extremely hard and durable. Large mounds indicate that the underground nests are of considerable age and the subterranean workings extensive.

When these mounds are constructed on arable land they interfere with routine cultural operations as they do with the mowing of grass when they occur on lawns. They are a nuisance on tea estates as they are often erected alongside tea bushes thus affecting their normal spread and development. The termites themselves are not primary pests of living plants and visit them only to feed upon such dead or diseased bark or wood as they may contain.

So far as is now known the mound-building habit is confined to three local species of termites *Hypotermes obscuriceps*, *H. marshalli* and *Cyclotermes redemanni*, but there are a large number of Ceylon termites which nest in the soil without forming a superstructure. In the case of the latter species it is extremely difficult to locate the main headquarters of the colonies and, consequently, their destruction is a very difficult matter.

The habit, followed by certain species, of erecting conspicuous mounds has the advantage of indicating the position in which the royal cell, around which the activity of the nest centres, may be looked for. It may be anticipated to lie about eighteen inches below the level of the surrounding ground immediately in the centre of the area covered by the base of the mound. Surrounding the royal cell, usually within a radius of about two to three feet in a large nest, are numbers of smooth-walled chambers which are packed with a friable sponge-like comb upon which is cultivated the fungus food for the young upon hatching from the eggs. The eggs are transported from the royal chamber as soon as they are deposited by the queen and they are at once conveyed to, and deposited in, the fungus combs which have been prepared for their reception.

There is a prevalent local belief that the death of the royal pair will terminate all further activity in that particular nest and it is the practice on some estates to pay as much as Re. 1-00 for every queen collected. When the royal cell has been located and removed further work on the nest is abandoned in the belief that the orphaned termites will perish. There is, however, no foundation for this current view and the removal of the original founders of the colony is an event which merely results in some temporary inconvenience to the members which remain. Arrangements are at once made to meet this situation and in a short time substitute royalties are produced to continue the population of the community.

It is necessary, therefore, in order to insure the destruction of a termite nest to exterminate the entire colony as well as the fungus combs upon which the eggs are situated. The young, upon hatching, are thus deprived not only of their food but also of the care of the older members of their community which they require in the early stages of their lives.

When the headquarters of a subterranean termite colony has been located its destruction can be effected in several ways. Fumigation with carbon bisulphide is a certain method but it is costly on a large scale. Fumigation with Cyanogas, liberated by the action of soil moisture on calcium cyanide when driven into the termite workings by means of a special force pump, is effective when the powder is fresh, but not otherwise. A method which has been practised with much success is the introduction, into the nests, of fumes generated by burning arsenic and sulphur in an apparatus consisting of a combined furnace and pump. The apparatus is costly and the method somewhat cumbersome for general use.

A method of destroying the nests of mound-building termites which has proved very successful in local tests is as follows and is recommended for extended trial. The mounds are first levelled to the ground if they form an obstruction which it is desired to remove. This may be effected with pickaxe and *mamoty* but if the mounds are large their demolition may be accelerated by blasting. A series of holes should then be driven into the area previously covered by the mound with the aid of an alavangoe, the depth of the holes being about 18 inches and their number depending upon the area concerned. In the writer's experience, the diameter of a large mound in Ceylon rarely exceeds eight feet at the base, but the average diameter may be considered to more nearly approximate half this width. As the ground has been considerably undermined little resistance will be offered to the passage of the alavangoe. One hole should be made in the centre of the area previously occupied by the mound. This

operation is not always necessary as a large hole will often be found in this situation being the entrance to the ventilating flue with which most mounds are provided to supply air to the subterranean abodes of these species of termites. A circle of holes should then be made around the centre about 18 inches apart and about equidistant between the centre and the circumference of the area to be dealt with. Into each hole should then be poured, through a long-necked funnel, one ounce of petrol, the hole being immediately plugged with well-rammed soil to prevent the escape of the petrol vapour. At the present price of petrol (Re. 1-50 per gallon) this treatment would cost one cent per hole for material, the total cost of treating a nest depending upon its size. An average-sized nest should not require more than 10-12 oz. of petrol and a large number of nests can be treated daily by one man providing that they are not situated too far apart. The cost of the preparatory operation of demolishing the mounds will depend upon their size and the methods employed.

This method of treatment results in the disintegration of the fungus combs within a few days of treatment and in the trials upon which this note is founded no survivors of treated colonies have been found when the above-mentioned dosages have been applied. Large numbers of dead termites may be encountered if the examination of the treated nest is not delayed too long, and the decomposing remains of the royal pair are to be seen when the queen cell is opened.

As new colonies are being continually formed by the winged pairs of the colonizing flights, particularly after heavy showers of rain at certain seasons of the year, it is necessary that constant inspections should be made for the formation of new mounds. In the early stages the mounds can be levelled without difficulty and the nests destroyed by the injection of petrol at a few points only.

The success which has attended the experimental stages of this method of destroying the nests of mound-building termites warrants its trial on a more extended scale and reports upon the success, or otherwise, of such trials will be received with interest.

MANURIAL EXPERIMENTS WITH RICE—PART III

L. LORD,

DEPARTMENT OF AGRICULTURE, CEYLON

THESE experiments have already been described and preliminary reports have appeared in this Journal*. The present paper reports further results and summarises all results to date. In addition general recommendations for the manuring of rice are made.

It was stated in Part I of this paper that it was intended to try other ammonium phosphates in a new series C. The results of this new series will be found in Tables I to IV. These are of considerable interest and will be discussed later. Tables V to XI summarise the results of all the trials to date.

The different series at the four stations have not all the same experimental value but even those which have been largely affected by soil heterogeneity and other causes are still of some use in indicating general manurial response. Undue importance must not be attached to the percentages figures in the Wariyapola trials. Owing to the very restricted water supply the yields of the control plots varied from 4 to 6¾ bushels per acre. These are very low yields and a small increase in yield due to the manures implies a very large percentage increase. In spite of the poor water supply at Wariyapola the response to the manures was remarkable and the increases obtained from some of the treatments were sufficient to meet their cost. It is probable that here the effect of phosphoric acid in stimulating root development gave the plants receiving this plant food an advantage throughout the whole growing period.

The effect of smaller dressings of green manure was investigated at Peradeniya during the *maha* season of 1929-30. Five and one-ton dressings of green material brought in from outside were tested and the results will be seen in Table XII. The trial satisfies the requirements of the *z* test. Wild sunflower, *Tithonia diversifolia*, was used to supply the green material. The one-ton dressing has given a very satisfactory increase in yield of grain. The dressing five times as great has given an increase two-and-a-half times as great. The cost of cutting and transporting green material is frequently high and it is not thought that in most places dressings of more than one ton per acre will be possible.

**The Tropical Agriculturist*, Vol. LXXIII, August 1929 and LXXIII, November 1929.

DISCUSSION OF THE RESULTS

These manurial experiments have not yet been carried out for a sufficiently large number of years to allow more than general conclusions being drawn as to the results of most of the treatments tried. There is very definite evidence of the value of green manure at all stations except Labuduwa where the soil is naturally richer in organic material but even at Labuduwa when the limiting factor of phosphoric acid is added the application of green manure has been beneficial. The decomposition of the organic matter furnished by green materials, weeds and crop residues not only supplies plant food for the rice plant but also supplies carbon dioxide for the algae which are supposed to be so important in the supply of oxygen to swamp rice. Where crops occupy the land for the majority of the year (as in parts of the Central Province) or where natural weed growth is poor in quantity (as in dry districts and where fields are grazed bare by cattle) the application of at least some additional green material is important and in some places may be essential if the full benefit of applying artificial fertilisers is to be obtained.

The application of superphosphate and steamed bone meal, alone, has given economical results at all stations and it must be concluded that phosphoric acid is perhaps the most important plant food to be added to Ceylon paddy soils. It is estimated that the application of 1 cwt. of ordinary superphosphate or of 100 lb. steamed bone meal will give on average soils an increase of about 25% with a residual effect on the succeeding crop of about 12%. The addition of small dressings of sulphate of ammonia to these manures has had no effect. There is evidence, however, that with larger dressings of superphosphate additional nitrogen will be effective and it is thought that if superphosphate is applied alone for a number of years yields will fall off unless nitrogen is also given.

The addition of potash to nitrogen and phosphoric acid has had no effect and it may be concluded that applications of potash are not necessary on Ceylon paddy soils.

Apart from the effects of phosphoric acid alone, and of green manuring, the chief interest in these trials is the effect of the different ammonium phosphates. The value of this compound fertiliser has been masked at Anuradhapura owing to the high fertility of the fields. The control plots yielded at the rate of 2,568 lb. per acre which for unmanured land is a yield which compares favourably with yields in any part of the world. Some explanation of the quantities per acre of the fertilisers used in this series is necessary. Treatments 1, 2 and 4 at the time the experiment was started were based on equal costs. Prices have varied since then. Treatments 3 and 5 contained similar

amounts of nitrogen as treatment 1 on the analyses then available. The data which is available here is not exhaustive but it indicates that moderate dressings of the amonium phosphates with the wider ratio of nitrogen to phosphoric acid are generally more effective. On less fertile soil it is probable that the use of a narrower ratio ammonium phosphate is advisable.

GENERAL RECOMMENDATIONS FOR MANURING PADDY FIELDS

1. For fields which carry between crops a luxuriant weed growth and where nitrogen can be assumed to be present in sufficient amount: $\frac{3}{4}$ to 1 cwt. concentrated superphosphate followed when yields go off by $\frac{3}{4}$ to 1 cwt. of a wide ratio ammonium phosphate.
2. For fields of average fertility: $\frac{3}{4}$ to 1 cwt. of a wide ratio ammonium phosphate followed in later years by 1 cwt. of a narrow ratio ammonium phosphate.
3. For poor soils and where the above fertilisers do not succeed in maintaining yields: 1 cwt. of a narrow ratio ammonium phosphate.

Superphosphate is best applied at the final ploughing and ammonium phosphate about a day before sowing or transplanting. The addition of green manure to the above dressings is recommended unless weed growth is very large. A suitable average amount to apply is one ton per acre but even smaller amounts will be beneficial.

Diammonphos and Leunaphos tried in the new series C are not now on the market. The ammonium phosphates available are as follows:

Wide ratio -	ammophos	13/46
	nicifos	17/45
Narrow ratio -	ammophos	20/20
	nicifos	22/18

The first figures show the percentage of ammonia and the second the percentage of phosphoric acid.

Information as to the optimum dressings per acre on different soils is not yet available but it must not be assumed that the amounts mentioned above are maximum dressings. It would, however, be unwise to exceed them unless the water supply is ample and the paddy varieties are moderately stiff-strawed.

ACKNOWLEDGMENT

In conclusion, I have pleasure in expressing my thanks to my assistants in the Division of Economic Botany without whose help these trials could not have been carried out.

Table I

LABUDUWA—MAHA 1929-30

New Series C

Treatment per acre	Yield per acre based on mean of 4 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2/- per bus.	Cost of manures F.O.R. Colombo
	lb.	Bus. of 48 lb.		Rs. cts.	Rs. cts.
1. 104½ lb. Ammophos 16N/20 P_2O_5 (16·72 lb. N + 20·9 lb. P_2O_5)	1512	31½	210·80	33 00	9 38
2. 96½ lb. Ammophos 11 N/45 P_2O_5 (10·61 lb. N + 43·42 lb. P_2O_5)	1565	33	218·11	36 00	10 77
3. 80 lb. Leunaphos 20N/20 P_2O_5 (16 lb. N + 16 lb. P_2O_5)	1242	26	173·17	22 00	7 74
4. 76 lb. Diammonphos 21N/53 P_2O_5 (15·96 lb. N + 40·28 lb. P_2O_5	1517	32	211·49	34 00	10 95
5. 80 lb. Sulph. of Ammonia (16 lb. N) 112 lb. Superphosphate (20·2 lb. P_2O_5)	1417	30	197·56	30 00	{5 00 {3 75
6. Control: no Manure	717	15	100·09	—	

Standard error of the difference between means = 10·53 %

z = 1·1748

5 % point z = ·5326

Table II

LABUDUWA—NEW SERIES C. YALA 1930

Residual Effects

Treatment per acre	Yield per acre based on mean of 4 plots of 1/100 ac.		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2- per bus.
	lb.	Bus. of 48 lb.		Rs. cts.
1. 104½ lb. Ammophos 16 N/20 P_2O_5 (16·72 lb. N + 20·9 lb. P_2O_5)	1345	28	118·76	9 00
2. 96½ lb. Ammophos 11 N/45 P_2O_5 (10·61 lb. N + 43·42 lb. P_2O_5)	1612	33¼	142·38	20 00
3. 80 lb. Leunaphos 20 N/20 P_2O_5 (16 lb. N + 16 lb. P_2O_5)	1237	25¾	109·27	4 50
4. 76 lb. Diammonphos 21 N/53 P_2O_5 (15·96 lb. N + 40·28 lb. P_2O_5)	1437	30	126·93	13 00
5. 80 lb. Sulphate of Ammonia (16 lb. N) 112 lb. Super (20·2 lb. P_2O_5)	1327	27¾	117·22	8 50
6. Control : no manure	1132	23½	100 00	—

Standard error of the difference between means = 15·94 %

z = ·0790

5 % point z = ·5326

Table III

ANURADHAPURA—MAHA 1929-30

New Series C

Treatment per acre	Yield per acre based on mean of 6 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs. 2/- per bus.	Cost of manures F.O.R. Colombo
	lb.	Bus. of 48 lb.		Rs. cts.	Rs. cts.
1. 104½ lb. Ammophos 16/20 (16·72 lb. N + 20·9 lb. P_2O_5)	2777	58	108·11	9 00	9 38
2. 96½ lb. Ammophos 11/45 (10·61 lb. N + 43 42 lb P_2O_5)	2908	61	113·23	15 00	10 77
3. 80 lb. Leunaphos (16 lb. N + 16 lb. P_2O_5)	3005	63	117·01	19 00	7 74
4. 76 lb. Diammonphos (15·96 lb. N + 40·28 lb. P_2O_5)	3102	65	120·77	23 00	10 95
5. **80 lb. Sulphate of Ammonia (16 lb. N)** **112 lb. Super (20·2 lb. P_2O_5)**	2793	58 1/5	108·76	9 40	{ 5 00 { 3 75
6. Control : no manure	2568	53 1/2	100·00	—	—

Standard error of the difference between means = 5·45 %

z = 0 5370

5 % Point z = 0·4783

N.B.—Results of residual effects were spoiled due to floods.

Table IV

WARIYAPOLA—MAHA 1929-30

Series C

Treatment per acre	Yield per acre based on mean of 2 plots of 1/100 acre		Yield expressed as a percentage of the control plot	Value of increased yield over control at Rs 2/- per bus.	Cost of manures F.O.R. Colombo
	Lb.	Bus. of 48 lb		Rs. cts.	Rs. cts.
1. **104½ lb. Ammophos 16/20** (16·72 lb. N + 20·9 lb. P_2O_5)	585	12	216·66	12 00	9 38
2. **96½ lb. Ammophos 11/45** (10·61 lb. N + 43·42 lb. P_2O_5)	510	11	194·44	10 00	10 77
3. **80 lb. Leunaphos** (16 lb. N + 16 lb. P_2O_5)	510	11	194·44	10 00	7 74
4. **76 lb. Diammonphos** (15·96 lb. N + 40·28 lb. P_2O_5)	500	10	185·18	8 00	10 95
5. **80 lb. Sulphate of Ammonia plus 112 lb. Superphosphate** (16 lb. N + 20·2 lb. P_2O_5)	550	11½	203·70	11 00	{ 5 00 3 75
6. **Control : no manure**	270	6	100·00	—	—

Standard error of the difference between means = 8·83 %

z = 1·3054

5 % point z = 0·8097

Table V
PERMANENT MANURIAL TRIALS
Series A

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots						
	Labuduwa		Anuradhapura		Peradeniya		Wariyapola
	1928-29	1929-30	1929	1930 (*double dose*)	1928-29	1929-30*	1929-30
1. Control : no manure	100 00	100·00	100 00	Trials spoiled due to floods	100·00	100·00	100·00
2. ½ cwt. Sulphate of Ammonia (11·2 lb. N)	97 35	68 38	106·27		109·66	95·69	192·86
3. As in 2 plus 1 cwt. Super (20·2 lb. P_2O_5)	112·63	115·44	104·50		114·99	98·26	198·98
4. As in 3 plus ½ cwt. Muriate of Potash† (28 lb. K_2O)	111·92	118·62	111·73		114·84	102·74	164·29
5. 1 cwt. Super. (20·2 lb. P_2O_5)	114·81	109·43	108·52		113·04	109·78	236·73
6. ½ cwt. Sulphate of Ammonia plus 5 tons Green Manure‡	107·61	75·24	118·00		135·29	110·70	202·04

* Results not reliable due to floods

† Muriate of Potash was replaced by Sulphate of Potash in 1929-30 and 1930

‡ 5 tons Green Manure were reduced to 1 ton in 1929-30 and 1930

Table VI

PERMANENT MANURIAL TRIALS

Series A—Residual Effects

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots				
	Labuduwa		Anuradhapura	Peradeniya	
	1929	1930	1929-30	1929	1930*
1. Control : no manure	100·00	100 00	100·00	100·00	100·00
2. ½ cwt. Sulphate of Ammonia (11·2 lb. N)	99·16	88·59	101·02	105 87	97·64
3. As in 2 plus 1 cwt. Super. (20·2 lb. P_2O_5)	107·01	108·89	106·60	124·58	97 98
4. As in 3 plus ½ cwt. Muriate of Potash† (28 lb. K_2O)	83 34	110·71	98·98	146·65	108 94
5. 1 cwt. Super (20 2 lb. P_2O_5)	101·51	109·39	98·23	129·33	112·48
6. ½ cwt. Sulphate of Ammonia plus 5 tons Green Manure‡	101·96	82·53	106·33	143·02	97·81

* Results not reliable due to floods

† Muriate of Potash was replaced by Sulphate of Potash in 1929-30 and 1930

‡ 5 tons Green Manure were reduced to 1 ton in 1929-30 and 1930

Table VII

PERMANENT MANURIAL TRIALS

Series B

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots						
	Labuduwa		Anuradhapura		Peradeniya		Wariyapola
	1928-29	1929-30	1929	1930	1928-29	1929-30*	1929-30
1. Control: no manure	100·00	100·00	100·00	Trials were spoiled due to floods	100 00	100·00	100 00
2. 91 lb. Steamed bone meal (2·73 lb. N+20 lb. P_2O_5)	171·99	131·89	108·96		104 65	103·81	280·28
3. As in 2 plus 42·35 lb. Sulphate of Ammonia (11·2 lb. N+20 lb. P_2O_5)	160 81	125·28	104·32		—	—	291 55
4. As in 2 plus 5 tons green manure †	171·53	175·39	107·88		128 17	106·68	274·64
5. 1 cwt. Superphosphate (20·2 lb. P_2O_5)	169 91	149·65	117·46		—	--	242·25
6. As in 5 plus 5 tons green manure †	190·90	176·53	109·27		—	—	291·55

* Results not reliable due to floods

† 5 tons green manure were altered to 1 ton in 1929-30 and 1930 — except at Anuradhapura

Table VIII

PERMANENT MANURIAL TRIALS

Series B—Residual Effects

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots				
	Labuduwa		Anuradhapura	Peradeniya	
	1929	1930	1929-30	1929	1930*
1. Control : no manure	100·00	100·00	100·00	100 00	100·00
2. 91 lb. Steamed Bone meal (2·73 lb. N + 20 lb. P_2O_5)	115·33	115·04	108·12	118·72	106·07
3. As in 2 plus 42·35 lb. Sulphate of Ammonia (11·2 lb. N + 20 lb. P_2O_5)	131·69	108·48	110·31	—	—
4. As in 2 plus 5 tons green manure †	127·47	112·00	100·39	144·97	115·68
5. 1 cwt. Superphosphate (20·2 lb. P_2O_5)	112·00	114·56	112·99	—	—
6. As in 5 plus 5 tons Green Manure †	139·52	103·68	106·99	—	—

* Results not reliable due to floods

† 5 tons Green Manure were altered to one ton in 1929-30 and 1930—excepting at Anuradhapura

Table IX

PERMANENT MANURIAL TRIALS

Series C

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots			
	Labuduwa 1928-29	A'pura 1929	Peradeniya 1928–29	Peradeniya 1929-30*
1. 93 lb. Ammophos (15 lb. N + 18·6 lb. P_2O_5)	169·40	108 81	125·44	85·87
2. 75 lb. Sulphate of Ammonia plus 104 lb. Superphosphate (15 lb. N + 18·6 lb. P_2O_5)	162·98	106·28	115·02	108·07
3. Control: no manure	100·00	100·00	100·00	100·00

* Results not reliable due to floods.

Table X

PERMANENT MANURIAL TRIALS

Series C—Residual Effects

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots			
	Labuduwa 1929	A'pura 1929-30	Peradeniya 1929	Peradeniya 1930*
1. 93 lb. Ammophos (15 lb. N + 18·6 lb. P_2O_5)	169·40	100·99	97·89	86·93
2. 75 lb. Sulphate of Ammonia plus 104 lb. Super (15 lb. N + 18·6 lb. P_2O_5)	143·17	98·89	104·22	83·33
3. Control: no manure	100·00	100·00	100·00	100·00

* Results not reliable due to floods.

Table XI
PERMANENT MANURIAL TRIALS
New Series C

Treatment per acre	Mean yield per acre expressed as a percentage of the control plots				
	Labuduwa		Anuradhapura		Wariyapola
	Manured 1929-30	Residual 1930	Manured 1929-30	Residual 1930	1929-30
1. 104½ lb. Ammophos 16 N/20 P_2O_5 (16·72 lb. N + 20·9 lb. P_2O_5)	210·80	118·76	108·11	Trials were spoiled due to floods	216·66
2. 96½ lb. Ammophos 11 N/45 P_2O_5 (10·61 lb. N + 43·42 lb. P_2O_5)	218·11	142·38	113·23		194·44
3. 80 lb. Leunaphos 20 N/20 P_2O_5 (16 lb. N + 16 lb. P_2O_5)	173·17	109·27	117·01		194·44
4. 76 lb. Diammonphos 21 N/53 P_2O_5 (15·96 lb. N + 40·28 lb. P_2O_5)	211·49	126·93	120·77		185·18
5. 80 lb. Sulphate of Ammonia 16 lb. N 112 lb. Super (20·2 lb. P_2O_5)	197·56	117·22	108·76		203·70
6. Control : no manure	100·00	100·00	100·00		100·00

Table XII

MAHA 1929-30

Peradeniya Paddy Station—Green Manure Experiment—Grain weights

Treatment per acre	Replications (Yield in lb.)				Total	Yield per acre		C=100%	Value of increased yield over control at Rs. 2-00 per bus.
	a	b	c	d		Lb.	Bus. of 48 lb.		
									Rs. cts.
1. One ton Green Manure	15·7	16·0	25·1	22·2	79·0	1975	41¼	140·82	24 00
2. Five tons Green Manure	23·5	22·5	36·4	26·9	109·3	2732	57	194·83	55 50
3. Control	15·3	7·9	21·6	11·3	56·1	1402	29¼	100·00	—
Block Total	54·5	46·4	83·1	60·4	244·4				

Standard error of the difference between means=8·94%

z=1 6491

5% point z=0·8188

RESEARCH WORK ON RUBBER CULTIVATION IN 1929*

Economy.—Luytjes and Tergast gave a third report on the situation of the native rubber in the Netherlands-Indies, covering the year 1928 and the first five months of 1929.

The exports of native rubber amounted in 1928 to 129,178 tons wet rubber (equivalent: 90,962 tons dry rubber) against an equivalent of 98,683 dry rubber in 1927. This diminution has to be attributed to the low prices in 1928. Many of the imported labourers left the rubber districts in this year—only in Djambi many of the imported Javanese coolies remained—while the tapping by the owners and the members of their families and the employment of local labourers increased. This change in the labour conditions brought a lowering of the expenses and the adaptation to the low prices of rubber. It may be expected, that in most districts tapping will go on regularly as long as prices do not fall lower than one shilling per lb.

Only in those districts, where the population has other important means of existence (especially in Tapanuli, west coast of Sumatra and Bangka) the decrease in production sets in at a higher market price.

The production that would be obtained if the native fields were all regularly tapped may be estimated at 135,000 tons for 1929. The area which is not yet in production may be estimated at two to three times the present area in production. The young fields have been planted from 1924 up to 1929 and are gradually getting into production. Lately planting of new fields has been done less on account of the low prices.

Another important report on native rubber in the Dutch East Indies is that of Taylor and Stephens, who visited the more important native producing districts by commission of the Rubber Growers' Association.

They point out that the planting of rubber by the natives rose to fever height in the boom years 1925-26 and has steadily declined since.

The stand of the trees is dense and large yields are obtained for some years. From the evidence collected average figures that appear to be applicable are:

Table I

Age	Pounds per acre
5 years	300
6 ,,	400
7 ,,	600
8 ,,	700
9 years and above	800

The number of trees per acre is very large (about 375) and accordingly the yield per tree is low.

In order to enable the tapper on the 50-50 share basis, still very common in all districts, to earn at present prices what is considered a sufficient remuneration, a good yield is essential, a general average of 4 to 5 lb. per diem (more usually the latter), being the usual return. And if such yields are not capable of maintenance even by the growing practice of larger tasks, tapping the trees becomes spasmodic and finally ceases, though this is still comparatively a rare occurrence.

* From *International Review of Agriculture* (Part 1, Monthly Bulletin of Agricultural [Scien]ce and Practice) Year XXI, No. 8, August 1930.

Bark consumption is rapid and generally after about two years the renewed bark is tapped, and this second tapping is nearly always a mass of wounds. The third tapping after another couple of years is still worse. To compensate for the declining yield from the single cut, one or more additional cuts at all angles and in any promising looking spot are added. This enables large yields per acre to be maintained up to about the twelfth year of age. Taylor and Stephens estimate that the decline in yield after six to seven years of tapping is probably not less than 10 per cent per annum. "Brown Bast disease" is very common.

It is estimated that taking the amount of native rubber planting done during the period 1923-28 the proportion planted in the various years was: 1923 almost nil; 1924 10 per cent.; 1925 30 per cent.; 1926 30 per cent.; 1927 20 per cent.; and 1928 10 per cent. On this basis a forecast has been made of what appears to the investigators to be the *potential* yields for the next five years. "But so long as prices between 9d. and 1s. per lb. prevail it is not thought that the potential yield will anywhere be realised."

The estimated areas under native rubber cultivation are as follows:

Table II

	Estimated areas (in acres)		
	Old	Young	Total
Pontianak ...	53,000	159,000	212,000
Bandjermasin ...	50,000	100,000	150,000
Palembang ...	53,000	265,000	318,000
Djambi ...	70,000	140,000	210,000

The estimated *potential* outputs for the years 1929-1933 are given. That of 1933 may be mentioned here:

Table III

Estimated Potential output (1933)

Pontianak	Bandjermasin	Palembang	Djambi	Total (estimated at 70% of the whole of the native rubber in the Neth. E.I.)
Tons	Tons	Tons	Tons	Tons
51,000	34,500	77,500	47,500	220,000

Botanical Research.—Morris gave a general review of previous investigations on the *Pollination and fertilisation* of the Hevea tree. He added the results of some of his own investigations on Pilmoor Estate, Batoe Tiga, Selangor (F. M. S.)

The supposition of Heusser, that pollination with pollen of another tree of the same clone would result in a higher percentage of fertilisation than self-pollination was not confirmed; pollination between different trees of clone A 44 remained without result; the same was the case between trees of clone B 58.

In his hybridisation experiments Maas (Sumatra) obtained up to 56% of successful cross-pollinations. Heusser (Sumatra) obtained in his cross-pollination experiments very different results with different combinations of trees. With some combinations, for instance, tree No. 29 pollinated with pollen of tree No. 141 no success at all was obtained, while with other combinations cross-pollination always resulted in a rather high percentage of fertilisations. The highest percentage was obtained in pollinating tree 138 with pollen of tree 146. Schweizer (Java) obtained 18% successful pollinations and Van der Hoop (Java) in 1924 35%, in 1926 35% and 1927 6·9%.

Morris obtained the following percentages of successful cross-pollinations in the different combinations:

Table IV

Combinations			Percentage of successful cross-pollinations
A 44 ♀	X	B 58 ♂	0·4
B 58 ♀	X	A 44 ♂	1
A 8 ♀	X	A 44 ♂	6
A 44 ♀	X	A 8 ♂	3
A 44 ♀	X	D 6 ♂	18

All the percentages must be regarded as low in comparison with those obtained in Java and Sumatra.

In the second series of his experiments Morris pollinated 7 mother-trees with pollen of different other trees. Of all these pollinations including 1248 flowers of 186 inflorescences, 91 fruits were obtained with 274 seeds, of which 205 germinated.

Thus 7% were successful.

The results of Morris' experiments of 1928 can be summarised as follows: 2290 flowers of 8 clones were pollinated; 1685 crosses gave 94 fruits, *i.e.*, 5·5 per cent. of success, and 213 seeds germinated. All the 605 self-pollinations failed.

Investigations on *correlation between vegetative characters and yield of rubber have been carried out by quite a large number of workers, the final object being selection of high yielders.*

Sanderson and Sutcliffe investigated this matter again.

In order to find out whether or not there was a close correlation between the number of latex vessel rows and the yield, the number of latex vessels in 485 trees was recorded at three different heights 5 in., 10 in. and 20 in. The average total of latex vessel rows at 5 in. was 15·27, at 10 in. it was 13·17 and at 20 in. 11·00.

For each girth increase of 4 in. at 20 in. there appears to be an average increase of one in the number of latex vessel rows. The correlation coefficient between the characters, girth and number of vessels is $+0{\cdot}44 \pm 0{\cdot}036$. This is sufficiently high to indicate a definite correlation, but not high enough to justify the assumption that trees of the greatest girth at 20 in. will also have the largest number of latex rows at that point.

A similar correlation exists between the girth at 20 in. and the yield. The correlation coefficient $(+0{\cdot}3983)$ is too low to justify selection of a small percentage of high-yielding trees by girth measurement alone, but is yet sufficiently high to indicate that large girth is a desirable character, since it has some influence on the yield.

Such *a correlation exists also* between the yield and the latex vessel rows at 20 in. *The coefficient is* $+0{\cdot}46 \pm 0{\cdot}2265$.

As regards the rubber content of the latex, this varied from 16% to 38%. The coefficient of variability 14·6 is so high that volumetric determination of yield cannot be relied upon; final determination of yield should be by actual dry rubber.

PLANTING AND REPLANTING

In planting seed of selected trees, we meet often the difficulty, that we get only a small number of seeds in consequence of the low fertility of a tree. In such a case the method which Ramaer described and which

gives *two seedlings from one seed,* will be useful. When the seed has germinated and the young stem has just emerged from between the cotyledons, the top of the stem is cut away and the base of the stem at a length of about ½ cm. above the insertion of the cotyledons is left. Thereupon the main root, the hypocotyl and the rest of the stem are split lengthwise. After some time the buds, situated in the axils of the cotyledons begin to swell and develop into two new stems, while two halves of the main root develop each into a new main root.

After the operation the plants must be treated with care and planted out into a loose soil. After some time, when a few green leaves have been developed, the cotyledons are exhausted and dry up, and the two plants stand independent from each other. A short period of rest sets in, in which, however, the root develops further; then the final buds develop again. At this time the seedlings must be transplanted. In the beginning these "twin-seedlings" are a little backward in comparison with ordinary ones, but after some time no difference is to be seen.

The question of rejuvenation of the old fields planted with planting material which is at present regarded as being of inferior quality, is still much discussed.

Koch proposed not to interplant between the old trees, but to apply a drastic tapping system during two years and to replant entirely in the third year. He calculates, that, if the old trees are left standing, they would produce in 18 years 3600 kg., rubber per bahu (0·7 ha.), while one would get from one bahu, if it is replanted with superior strains, in 18 years consecutively: 400 kg., 400 kg. 100 kg. (from the old heavily tapped trees), then four years no yield, and the following years: 120 kg., 200 kg., 270 kg., 270 kg., 340 kg., 420 kg., 460 kg., and finally 500 kg. per bahu, or altogether in 18 years 4710 kg.

Drastic tapping of the old trees before removing is also recommended by Vollema. The system he applies consits in tapping daily witb two cuts each over half circumference. The yield thus obtained during three years is three times the ordinary yield. After these three years the old trees are removed and the whole field is replanted.

The question of replanting, rejuvenation and supplying of old fields is also a subject of discussion in a paper of Sutton. It is the opinion of the author, that this question must seriously be considered for old rubber fields, even if the production is still some 400 lb. per acre (450 kg. per ha.). Replanting, *i.e.,* removing all the trees and replanting the whole field is, in the opinion of the author, to be preferred if the field taken as a whole is no longer first rate and he considers it advisable to replant every year 1/20 part of the whole plantation, thus the whole plantation being renewed in 20 years. Rejuvenation, *i.e.,* the removal of some 60 or 70 per cent. of the original stand should be applied where there is a good proportion of sound rubber. Supplying, consisting in removing some 30% of the trees, should be applied in the best fields. The whole scheme may be then, that replanting is begun with the worst fields and supplying with the best fields, which will presumably be the last to be replanted in the 20 years of replanting.

In replanting great attention must be paid to the tapping out of the area. A general method of tapping out is difficult to give, the method must have regard to former tapping systems, but as a general rule every day tapping should be instituted as soon as is possible and a five-year basis should be taken. The felling and removal of stumps is a formidable work and, if done by hand a most expensive one. The author recommends using monkey winches and tools of the "Handy Andy" and "Forest Devil" description. Jacks are useless for this type of work. A gang of about five coolies is sufficient for one machine, which can deal with from 15 to 25 trees

per day. Promiscuous burning should on no account be allowed as it impoverishes the soil. In hilly terrain contour terracing is recommended. On lands where the subsoil is heavy or lacking in porosity, the interplanting of *Albizzia* has been found most advantageous in the breaking up of the subsoil.

After the soil has been dug in the ordinary way, the trees can be planted. The great question is: what planting material should be used? if only seedling from selected trees are planted a very close initial stand should be taken, say about 250 to the acre (about 625 per ha.). But the author prefers to plant alternately seedlings and budded trees, with an initial stand of 200 trees to the acre (500 per ha.) and a final stand of 90 to 100 in ten years. As regards rejuvenation, the author gives an example of a field of 24 acres having 78 trees to the acre and yielding 312 lb. per acre. *Of these 78 trees those, which give less than 4·8 lb. rubber (per year) are removed. This is the case with 56 trees; 22 with a production of 4·8 lb. or more per year are left. These trees give 138 lb. rubber per year.*

The different systems to be followed in terracing or a clearing were discussed by Holland. Holland discussed: (1) whether holing is to be done before or after terracing; (2) the distance apart of the terraces, and the spacing of the plants in the terraces; (3) the width and slope of the terraces. In 11 figures the main types of terraces are represented.

SOIL AND MANURING

De Vries gave a short review of the manuring experiments in Java.

In total 94 experiments were running in 1928, 17 of which with young trees, *but only 51 of these came up to the requirements of method. Of these 51 experiments, 9 were running for a too short time to allow an opinion about the results, while with 12 the result was more or less dubious; 21 experiments gave a positive result.*

Apart from the experiment at Djasinga Estate, Serpong Estate and Soekamadjoe Estate, in which the manuring (sulphate of ammonia gave an increase in yield of 20%, 35%, and 25% the following successful manuring trials must be mentioned.

Nitrogen-manures gave an increase in yield on the following estates: Soekamadjoe (young volcanic soil) (diammonphos more successful than sulphate of ammonia), Parakan Salak and Tjilentab (both on young volcanic soil), Soemoerbarang and Tjibaroekgak (tertiary soils), Boeniseuri (tertiary volcanic soil) Pondok Gedeh (young volcanic soil). Potassium manure seems to have some effect on the estates Bodjong Godeh (boundary between young volcanic and tertiary soil).

Lime seems to have some effect on the soil of the estate Tjikasintoe.

Nitrogen-phosphor manure gave an increase in growth of nursery plants on the estates Djasinga, Soekamadjoe and Tjikasintoe (boundary between tertiary tuff and marly soils).

Nitrogen-phosphor-potassium manure had effect on nursery plants on estates Serpong and Bolang.

As regards the method of determining the need of manure of the old fields by means of manuring experiments in nurseries, in six cases this method was tried and the results compared with those of direct manuring experiments in the field. In five of these cases the results did not correspond and in one case the correspondence was dubious. The "nurser - manuring-method" thus does not seem recommendable with rubber.

In Ceylon Roy Bertrand carried out a manuring experiment with pots and lawn plots. The object of the experiment was to test the amount of root growth induced in mature rubber by the application of different manures. 11 different manures were tried, both organic and inorganic ones. As the author correctly points out this experiment must only be considered tentative and it is only able to give indications in some directions. The author considers that it appears from this experiment: 1. that inorganic manures produce as much root growth or more than an equal value (monetary) of organic manures; 2. that alkaline or neutral fertilisers appear best suited to the soils in question; 3. that the effect of organic manures does not appear to last longer than that of inorganic ones.

An account, given in 1928 by Lord, of a statistical examination of the results of the manurial experiments 1914-1924 is revised by this author in which revision the yields of the different plots are figured out with use of the "regression coefficient." This method has recently been used by Eden in examining the effect of lime on tea (see *Tea Quarterly*, 1929, Vol. II, Part 1, page 8.)

In order to give an idea of the yields obtained, those of the two first years may be mentioned here:

Yield of dry rubber per tree

Year	Control plot	Manured plot
1914	2·69	2·37
1915	3·62	3·50
1926	5·50	6·06
1927	5·44	7·31

The manurial plot received per acre yearly: groundnut cake 182 lb., steamed bone meal 43 lb., blood meal 100 lb., and sulphate of ammonia 150 lb.

The value of the regression coefficient for the two series of yields for the whole period of the experiment is +0·1085 and the conclusion is that the manured plot has gained on the control plot at the rate of 0·1 lb. per year and that this gain is due to the manurial treatment. This figure of 0·1 lb. shows the cumulative effect of the manure over a period of fourteen years. The mean average increase of the nitrogen over the control plot is 0·5 lb. and it is this figure which should be used in judging the profitableness of the treatment.

THINNING OUT

Whether Ashplant's method of using the diameter of the latex tube as an indication of the yield will indeed prove useful in plantation practice is, according to De Vries, still quite uncertain. Ashplant has not yet given a complete exposition of his method and we are left in ignorance about the way of preparing, colouring and measuring the latex tubes in the leafstalks of the young plants. But, apart from this fact, Ashplant gave figures which show a rather close correlation between the diameter of the latex tube and the production in old trees; we have however no proof, that there is also correlation between the diameter of the latex tube of the *young* seedling in the nursery and the yield of the tapped tree. Another weak point in the method of Ashplant is the fact, that he figured out the average diameter of the latex tube of each plant by measuring 120 latex tubes. For plantation practice such a large number of measurements would be impossible, but then the question arises, how great the error is when a smaller number of measurements are made.

De Vries figures out how great the difficulties would be in applying Ashplant's method, even if we satisfy ourselves with eliminating in the nursery 25% of the plants viz. those with the smallest latex tube diameter, or (other method) in selecting for planting out only the 25% with the largest diameter, making only one measurement (and not 120) for each plant. In the last mentioned case—*i.e.*, planting out the 25% best plants—a gang of 3 to 4 trained laboratory workers would need 10 days for selecting the plants for one hectare, and if 100 are to be planted in 4 months a gang of at least 12 laboratory workers would be husy during that time. These considerations show clearly, that Ashplant's method—even if it would be a reliable one, which is quite uncertain—is unsuitable for plantation practice. De Vries thinks it possible that the method may have some value for the work of testing the different clones.

TAPPING

The fact that the yield of budded trees decreases less rapidly than that of seedlings with the distance from the soil opens a large field of investigation.

De Vries published the result of an experiment, in which 5 budded trees were tapped with two cuts above each other two budded trees with three cuts and one with four. The trees were budded in December 1920 and in June 1919 and planted over in January and February 1921. They were tapped from May to October 1926 over 1/3 three times every week.

The results are given in the following table :

Table VI

Tree No.	Cut	Height of the cut *in metres*	Sector	Yield per tapping in *grammes*	Yield of the upper cut in *percentage of* the yield of the lower cut.
53	lower	½	—	7·0	—
	upper	2½	same	3·95	57
68	lower	½	—	11·5	—
	upper	3¾	same	5·4	47
76	lower	½	—	6·4	—
	middle	2½	same	3·2	50
	upper	3¼	same	4·4	69
78	lower	½	—	8·6	—
	upper	2½	other	6·1	71
79	lower	½	—	6·1	—
	middle	2½	same	2·6	43
	upper	3¾	same	4·05	67
80	lower	½	—	6·15	—
	middle 1	2½	other	2·9	47
	middle 2	3½	same	2·65	43
	upper	3½	other	2·8	46
81	lower	½	—	7·0	—
	upper	3	other	5·0	71

In this case the average yield of the lower cut was 7·55 gm. The yield of the upper cut was 43 to 71% of that of the lower cut, and on an average 61%. No essential difference could be seen between the upper cuts at different heights or between the upper cuts in the same sector and those in another sector. As a preliminary conclusion it can be stated that an upper cut of a budded tree at a height of 2½ to 3 m. produces still about 60% of the yield of the lower cut.

Vrolyk published results of a similar experiment. Four plots were used in this experiment, viz. R1, W1, R2, and W2; they consisted of 13, 10, 10 and, 12 budded trees. The trees were tapped on 1/3 every other day from Nov. 1927 to May 1928. The average yield of dry rubber per tapping was in that time as follows :

R 1 :	13·1 gm.
W 2 :	14·97 gm.
R 2 :	22·03 gm.
W 1 :	15·45 gm.

On 1st June 1928 the plots R 1 and W2 were used for a two-cut tapping, while R 2 and W 1 were used as control and tapped as before with one cut. At the beginning of the experiment the lower cut on the trees of the plots R 1 and W 2 was situated at a height of 30 to 50 cm. above the soil; the upper cut was applied at a distance of 1·5 m. above the lower cut.

A comparison of the yield obtained on the four plots, before and after the two-cut system was applied in plot R 1 and W 2, is given in the following table :

Table VII

	Yield per tapping in grams of dry rubber					
	Control plots			Experimental plots		
	W 1	R 2	Average	R 1	W 2	Average
Preliminary tapping (one cut in the four plots) ...	15'45	22'03	18'74	13'1	14'97	14'035
Experimental tapping (one cut in the control plots and two cuts in the experimental plots) ...	16'13	24'28	20'20	23'70	26'13	24 9
Yield of the experimental tapping expressed in percentages of the yield of the preliminary tapping	104 %	110 %	108 %	181 %	174 %	177 %

The surplus of yield of the experimental tapping above the preliminay tapping is therefore 69% heigher in the experimental plots than in the control plots.

While in the experiment described by Vrolyk the upper cut was located in the same sector as the lower cut, Heusser and Holder applied on budded trees a system in which the two cuts are placed on two adjacent tapping areas, each of which occupies one quarter of the circumference, the vertical distance of the two cuts is 1 m. The left hand cut (panel 2) was started at two metres, the right hand cut (panel 1) at 1 metre above the union of stock and scion (quite near the surface of the soil). When (panel 1) will be tapped up to the union of stock and scion (near the soil), the panel 3 will be opened at a height of two metres, and when panel 2 will be finished, panel 4 will be opened at a height of two metres.

With this system with alternate monthly tapping and with a bark consumption of 45 mm. (1¾) per month (27 cm. per year) a bark renewal period of 14½ years is provided for.

This new system was applied to 300 five-year-old budgrafts, 100 of each of the clones 51, 80 and 65. For control budgrafts and seedlings were tapped with one cut over ⅓.

Putting the yield of the seedlings at 100 the following figures were obtained of the yield of the budgrafts :

Table VIII

	Old system (⅓ cut)	New system (¼ double cut)
Clone 51	142	192
Clone 80	170	206
Clone 65	183	277

If we put the yield of the budgrafts tapped at ⅓ at 100, the following figures are obtained :

Table IX

	Old system (⅓ cut)	New system (¼ double cut) Total	Upper cut	Lower cut
Clone 51 ...	100	135	65	70
Clone 80 ...	100	121	58	63
Clone 65 ...	100	151	71	81

From these figures it is apparent, that the new tapping system has given very promising results. Clone 65—an average clone—produced with this system 870 kg. per hectare of 200 trees, a yield which has never been obtained with the ordinary tapping system of any clone in its sixth year.

Another new tapping system was described by J. Bosch. It consists in dividing the cut into two (or more) cuts, separated from each other by a small piece of bark. The length of each cut being shorter the system allows a less steep slope of the cut, which results in more latex per cm. The inventor claims that in tapping with this system, in which a narrow stripe of bark is left untapped between the two or more parts of tapped bark, the sap-flow of the tree is furthered, and he assumes that this will have a beneficial effect on the bark renewal. This system has apparently not yet been tested.

It has been suggested, that bast, treated for brown bast disease by the scraping method as advised in *Rubber Research Scheme Bull.* No. 48, would be after renewal more readily affected by this disease.

Mitchell is of opinion that this is not the case and gives a photograph of a tree which has been tapped for over two years on the third day system and is now continuing to give satisfactory yields, without any indication of brown bast development.

In this connection it may be remembered, that in Java and Sumatra the treatment of brown bast by removing the diseased part of the bark is no longer done, since it has been proved that the diseased tree recovers well, if only the cut is made shorter. After the tree has been tapped with a cut of ¼ to ⅛ either every-other-day or with a periodical tapping system (for instance every-other-month) the tree recovers within a short time.

The question as to what period of tapping is the most profitable was the subject of an elaborate study of Schweizer. It was Hoedt, who pointed out a few years ago (*Archief voor de Rubbercultuur in Nederlandsch-Indie*, Vol. 10 (1926) P. 566), that in using systems of periodical tapping the yearly yield is different with different periods used; it may make a great difference whether the tree is tapped every other week or every other month.

This is the consequence of the so-called "wound response" *i.e.*, the fact, that after a period of rest a tree does not give immediately its highest yield, but only reaches its maximum daily yield after a certain number of tappings. After having reached this maximum we see a decrease set in. It is obvious that it is not economical to choose the tapping period so short that tapping is stopped before the maximum yield is obtained, nor continuing tapping so long, that the decrease in production has passed a certain limit. It is thus the course of the increase-decrease of yield which determines what length of tapping period is the most economical.

Schweizer shows, that the increase-decrease curve depends on the intensity with which the tree recovers its production. In fields with a high yield the trees reach a higher maximum after rest and take a longer time to reach this maximum; in fields with a lower latex-production the trees—speaking generally— reach a maximum which is lower and which is obtained in a shorter time (after a smaller number of daily tappings). As a general rule it may be said that under conditions which allow a high yield the increase in production lasts longer, and a higher maximum is obtained, than under conditions which do not allow of such a high yield.

It is well known that the yield of the trees, when tapped every day, or every other day, is not the same in different months: some three months after wintering—*i.e.*, generally in the month of October in Java—the tree gives the highest yield, then a decrease of yield takes place till about January, again an increase takes place and a second top of the yield-curve is reached in June; in July the yield decreases again and in August the yield is at its lowest. Accordingly, when the tree is tapped every other month, the increase-decrease curves are different in the different months: in the months of high yield the top of the increase-decrease curve is attained after a longer time than in the month of lower yield. This may be illustrated with the following figures:

A field, which gave its highest yield in October, followed by a decrease till February, followed by an increase till June, followed by a decrease till August, followed by an increase till October, was tapped every other month. The number of days the trees were tapped till the maximum production was reached was as follows:

	April	June	August	October	December	
Maximum yield reached after:	13	16	9	21	10	days

In this case—which was published by Hoedt—it was not economical to tap every other month, because the last part of the month (sometimes, August, even the last 22 days) the yield decreased again, and it would have been better to stop tapping at an earlier date, *i.e.*, to make the tapping periods shorter. An experiment with tapping every other fortnight confirmed this supposition; indeed 19% more rubber was obtained than with the every-other-month tapping system.

The general rule is therefore: in fields with a low production a higher yield is obtained when short tapping-periods are used, in fields with a large yield a higher yield is obtained with longer tapping-periods. In theory the ideal would be to fix the most profitable length of period for each field, but this is practically impossible. We may be satisfied when each planter determines what is the most profitable average period for his fields; in some cases it will be advantageous to make a difference for two parts of the estate, if there is a marked difference in yield between one part and the rest of the plantation.

MANURIAL EXPERIMENTS ON HEVEA

THE *present paper gives the continued* results over the last three years of the "Second Nitrate Manuring Experiment," the previous results of which were communicated in former papers (1), (2), and in addition the results of a new experiment on red liparite tuff soil.

SECOND NITRATE MANURING EXPERIMENT

The complete yield data of this experiment for the years 1927-1928, 1928-1929 and 1929-30 are given in table 1. The results given each year are discussed below. The tapping system of the experiment remains the same *as previously, namely, daily tapping on half of the circumference in alternate* months using 2 in. of bark per tapping month.

Ninth year, March 1927-February 1928.—The C. plots received the *usual annual application of* 5 lb. (2·27) kg.) *sodium nitrate per tree in* February 1927 and gave a yield of 672 lb. per acre (753 kg per ha) for the year,which was considerably in excess of any previously obtained, and the highest yield reached up to that time.

The B plots received 4 lb. (1·81 kg.) of ammonium sulphate per tree in February 1927, this now being a standard annual application for these plots beginning from 1926. The yield for the year was 426 lb. per acre (478 kg. per ha), the highest yet secured from this series.

The E plots, being manured in alternate years with 4 lb. (1·81 kg.) ammonium sulphate, received no manure in 1927 and gave a yield of 574 lb. per acre (664 kg. per ha), again the highest yet secured.

The D plots received 2 lb. (0·9 kg.) ammonium sulphate per tree in February 1927, this now being the standard application for these plots once in two years, commencing with 1925. The yield for the year was 472 lb. per acre (529 kg. per ha), also the highest to date.

All manured plots continued to show progress in general appearance and this improvement was perhaps most marked in the B series, now on an annual manuring basis after several years of no manuring.

The control plots (A series) continued to exhibit the same deteriorated appearance. The yield, however, showed some improvement being 307 lb. per acre (344 kg. per ha), the highest recorded since 1920-21.

Tenth year, March 1928-February 1929.—The C plots received the usual annual application of 5 lb. (2·27 kg.) sodium nitrate per tree in February, 1928 and reached the astonishing yield of 764 lb. per acre (858 kg. per ha) for the year. A stage has been reached in these plots at which further *improvement in appearance is not noticeable. The continued increase in* yield, far beyond that which was originally anticipated, is remarkable.

The B plots received the usual annual application of 4 lb. (1·81 kg.) ammonium sulphate per tree in February 1928, and gave a yield of 531 lb. per acre (595 kg. per ha) for the year, a new high record for the series.

* By J. Grantham in *Archief voor de Rubbercultuur*, No. 9, Sept., 1930.

(1) *Manurial Experiments on Hevea, Archief voor de Rubbercultuur* VIII, No. 8, August, 1924. (Summary published in *The Tropical Agriculturist*, Vol. LXIII, No. 5, p. 259.)

(2) Manurial Experiments on Hevea II, *Archief voor de Rubbercultuur* XI, No. 10, October, 1927. (Reproduced in *The Tropical Agriculturist*, Vol. LXXVI, No. 1, January, 1931.)

The E plots received the biennial application of 4 lb. (1·81 kg) ammonium sulphate per tree, which has continued since 1920, and reached a yield of 671 lb. per acre (752 kg. per ha) for the year, the highest yet secured from any series except series C for this year.

The D plots were not manured in 1928, but showed a further increase in yield to 530 lb. per acre (594 kg. per ha).

The control A plots gave a yield for the year of 361 lb. per acre, (405 kg. per ha) the highest so far secured. The reason for the increased yield in these plots is not quite clear, since the appearance of the plots was very poor. The increase is, however, smaller than in any of the other plots.

Eleventh year, March 1929-February 1930.—The C plots received the usual annual application of 5 lb. (2·27 kg.) sodium nitrate per tree in February. The yield for the year amounted to 757 lb. per acre (849 kg. per ha) just below that for the previous year.

The B plots received the usual annual application of 4 lb. (1·81 kg.) ammonium sulphate per tree in February 1929 and yielded for the year 546 lb. per acre (612 kg. per ha), an increase of 15 lb. per acre (17 kg. per ha) over the previous year.

The E plots were not manured in 1929 and yielded 656 lb. per acre (735 kg. per ha), just below the yield of the previous year.

The D plots received the biennial application of 2 lb. (0·9 kg.) ammonium sulphate per tree and yielded 525 lb. per acre (588 kg. per ha) for the year, again just below the yield of the previous year.

Many trees in the control A plots showed continued severe deterioration, main trunks and branches dying back. Other trees seem to have become stabilized and are not deteriorating. The yield amounted to 358 lb. per acre (401 kg. per ha) for the year or about the same as the previous year.

GENERAL REMARKS

The period under review has shown an increase in yields from all plots. In particular the C and E plots, which have received the longest regular manuring, have reached levels, which were previously quite unanticipated.

The B plots, now on regular annual manuring, after a period of 6 years (1919-24) during which no manuring was carried out, have shown the greatest rate of increase. Although manured annually with 4 lb. (1·81 kg.) per tree of ammonium sulphate since 1926, they are, however, still very much behind the E plots which have been manured once in two years since 1920 with 4 lb. (1·81 kg.) ammonium sulphate per tree. It seems probable that the deterioration, which took place in these plots during the years of no manuring, was sufficiently severe to prevent a rapid recovery in yield on the resumption of manuring. In appearance these plots are now almost equal to the plots annually manured with sodium nitrate and the yield is rising at a more rapid rate.

The D plots, manured with only half the normal quantity per tree in alternate years, showed the lowest yield of the manured plots. As with the B plots, however, these plots have not yet been on the present system of manuring for a sufficiently long period to render direct comparison with the older manured plots justifiable.

The rise in yield per acre of the control plots is an unexpected feature in the results and it is difficult to know to what this is to be attributed. The roots of the control plots, along the sides of the boundary ditches were cut previous to the manuring of 1930, in order to prevent them spreading underneath the ditches. During this work it was found that such spread of the roots occurred but seldom. A mass of feeding roots from the control plots was, however, found along the bottom of the ditches. Possibly a certain amount of manure has been washed from the manured plots to the ditches in

and adjoining the control plots, and absorbed by these feeding roots. In appearance the condition of the control plots is deplorable. It seems certain that an appreciable percentage of the trees will die in the next few years and, while other trees appear to have become stabilized, their general condition and bark renewal is very poor.

It will be seen that the yields of the 11th year, with the exception of that of series B, which shows an increase of 15 lb. are all a few pounds per acre below the yields for the 10th year. The actual difference in yield is inappreciable, but the steady increase, which has been characteristic of the last few years, did not take place. Whether this indicates that we are reaching a stage at which the maximum results have been secured, or whether the halt is merely a temporary one, cannot yet be decided. Up to the middle of 1929 it seemed probable that the previous year's yields would be exceeded. The somewhat disappointing yields of the latter half of the year were characteristic of yields in general and it is probable that the abnormally dry weather in the middle of the year had a prejudicial effect on subsequent yield. It must, therefore, be left to the future to determine whether the maximum yield has yet been reached by manuring.

NEW EXPERIMENTS ON RED SOIL

In the original paper, an experiment showing the effect of various artificial manures, including sodium nitrate, on six-year-old trees on red liparite tuff soil on Goerach Batoe was described. This experiment ran for 16 months, but, contrary to the results obtained on the white soil, no significant effect was produced on either yield or appearance. The yield and growth of the trees without manure were quite satisfactory. In more recent years, however, it has been observed that, after the trees on the red soil reach an age of from 12-15 years, deterioration gradually sets in. The foliage becomes perceptibly thinner and yellower and the leaves smaller. Bark renewal becomes less satisfactory and the yield falls off. These features are not unlike those previously observed on the white soil, but occur more gradually and before deterioration starts, the trees are much larger and more vigorous and give a higher yield per acre.

As an example of the falling off in yield, which is occurring on the unmanured red soil, the following yields from an experimental area of ±200 acres may be cited:

Age (Years)	Lb. per acre	Kg. per ha
8	525	588
9	610	684
10	618	693
11	635	712
12	535	600
13	525	588
14	454	509

Nitrogen Manuring Experiment, Goerach Batoe.—As a result of the above observations an experiment was laid out in February 1926 in 15-year-old rubber where this deterioration* was already evident, on a red liparite tuff soil, on Goerach Batoe. The experiment consists of four series of plots which receive the following treatment:

* No separate yields for the precise area occupied by the experiment for the years preceding the experiment are available, but deterioration in appearance was quite plain. The block had previously the reputation of being a high-yielding area and it is almost certain that the experimental area previously exceeded 600 lb. per acre or 673 kg. per ha. at the time of its maximum yield. It will be seen from table 2 that during the first three years of the experiment, the control plots show a rising yield, the fourth year being very little less than the third. No clear explanation can be advanced for this increase in yield, but the highest yield that of 1929, is certainly below the maximum obtained in the best days of the area.

Series A Control

,, B manured with 4 lb. (1·81 kg.) ammonium sulphate per tree annually.

,, C manured with 5 lb. (2·27 kg.) sodium nitrate per tree annually.

,, D manured with 5 lb. (2·27 kg.) sodium nitrate in alternate years.

Each series consists of eight individual plots of equal size, isolated by ditches, containing an average of ±60 trees each, with a total area for each series of 6·6 acres (2·67 ha). The individual plots are arranged in usual chess-board fashion and the tapping tasks planned so that each tapper taps an equal area of each series. The tapping system is the normal estate system of one half cut alternate month, using 2 in. of bark per tapping month. All plots are clean weeded, except for the soil conservation bunds and the berms along the ditches, which are covered with vigna.

The first application of manures was made in March 1926. The yield results to date are shown in table II.

In the first year, although some slight improvement was noticed in appearance, the effect of the manuring on yield was nil. After the second manuring of series B and C in February 1927, the improved appearance of the foliage in these plots was definite and the yields of the manured series, during the second year of the experiment, showed improvement. The *difference was, however, only just sufficient to be significant* (percentage increase required in order to be significant 6%). Following the third manuring of series B and C and the second manuring of series D in March, 1928, the improvement in appearance became more pronounced and, during the third year of the experiment, definitely improved yields were obtained, which continued for the fourth year of the experiment. The best series is now series B, which gave a yield of 18% more than the control in the fourth year. The percentage increases are, as yet, comparatively small in comparison with those obtained on the white soil and comparisons of the yields of the manured series between themselves are subject to a probable error, which renders the differences of no significance. All manured plots are, however, giving definite increase over the control and although, with a low rubber price, the certain increase in yield little more than pays for the cost of manuring, the yields may be expected to increase in subsequent years and the manuring results in a much healthier condition of the trees. It will be noted, however, that the yields of the control plots are at a much higher level than those on the white soil.

Other and more recent experiments are in progress on the red soil, the results of which it is hoped to publish at a later date. These experiments, on combined nitrogen and phosphate manuring, were initiated in 1928 as a result of favourable results on growth, obtained with nitrogenous and phosphatic manures in nurseries on the same soil type. It may be said, at present, that these experiments confirm that on Goerach Batoe recorded above, in so far that a beneficial effect on yield is being obtained from the application of nitrogen, but in no case can any additional effect yet be attributed to the phosphatic part of the manure.

Table I

Yields in lb. per series of plots, total area each series 6 acres, 1st latex and lump only. *Lower figures show percentage relationships to control series A.*

Series	Treatment in 1927	1927 March 17th-April 15th	1927 May 17th-June 15th	1927 July 17th-August 15th	1927 Sept. 17th-October 15th	1927 November 17th-December 15th	1928 January 17th-February 15th	Total March 1927-Feb. 1928	Lb. per acre per year	Kg. per H.A. per year
A	Control	172 100	276 100	345 100	319 100	353 100	376 100	1841 100	307	344
B	4 lb. ammonium sulphate per tree—February	262 152	370 136	448 130	438 137	513 145	518 138	2555 139	426	478
C	5 lb. sodium nitrate per tree—February	506 294	616 223	712 206	648 203	751 212	799 213	4032 219	672	753
D	2 lb. *ammonium sulphate* per tree—February	284 165	465 168	520 151	475 149	559 158	530 141	2833 154	472	529
E	None	364 212	560 203	622 180	588 184	675 191	638 170	3447 187	574	644

Series	Treatment in 1928	1928 March 17th-April 15th	1928 May 17th-June 15th	1928 July 17th-August 15th	1928 Sept. 17th-October 15th	1928 November 17th-December 15th	1929 January 17th-February 15th	Total March 1928-Feb. 1929	Lb. per acre per year	Kg. per H.A. per year
A	Control	220 100	328 100	414 100	397 100	409 100	401 100	2169 100	361	405
B	4 lb. ammonium sulphate per tree—February	351 160	489 149	602 145	547 138	584 143	614 153	3187 147	531	595
C	5 lb. sodium nitrate per tree—February	572 260	717 218	864 209	786 198	782 191	863 215	4584 211	764	858
D	None	354 161	489 149	622 150	549 138	572 140	595 148	3181 147	530	594
E	4 lb. ammonium sulphate per tree—February	481 219	639 194	745 180	697 175	719 176	746 186	4027 186	671	752

Series	Treatment in 1929	1929 March 17th-April 15th	1929 May 17th-June 15th	1929 July 17th-August 15th	1929 Sept. 17th-October 15th	1929 November 17th-December 15th	1930 January 17th-February 15th	Total March 1929-Feb. 1930	Lb. per acre per year	Kg. per H.A. per year
A	Control	307 100	354 100	430 100	357 100	357 100	343 100	2148 100	358	401
B	4 lb. ammonium sulphate per tree—February	469 152	512 145	620 144	517 145	547 153	610 178	3275 155	546	612
C	5 lb. sodium nitrate per tree—February	738 240	713 201	856 199	689 193	739 207	804 234	4539 211	757	849
D	2 lb. ammonium suphate per tree—February	471 153	512 145	605 141	501 140	523 147	541 158	3153 147	525	588
E	None	609 198	636 180	743 173	621 174	657 184	672 196	3938 183	656	735

TABLE II

Yields in lb. per acre 1st latex plus lump only—Manuring Experiment on Red Soil—G. Batoe. Lower figures show % relationships to control.

Series	Treatment in March 1926	1926 March	May	July	September	November	1927 January	Year 1926-1927 Lb. per acre	Kg. per H.A
A	Control	61·3 100	64·1 100	81·1 100	67·2 100	66·8 100	73·4 100	414 100	464
B	4 lb. ammonium sulphate per tree	59·8 98	65·4 102	79·6 98	67·0 100	67·1 100	73·5 100	412 100	462
C	5 lb. sodium nitrate per tree	58·0 95	63·5 99	77·8 96	69·0 103	67·7 101	73·4 100	409 99	458
D	5 lb. sodium nitrate per tree	64·3 105	67·9 106	82·9 102	66·7 99	70·7 106	73·7 100	426 103	478

Series	Treatment in February 1927	1927 March	May	July	September	November	1928 January	Year 1927-1928 Lb. per acre	Kg. per H.A.
A	Control	66·7 100	76·8 100	81·8 100	79·9 100	83·7 100	79·6 100	468 100	525
B	4 lb. ammonium sulphate per tree	71·5 107	80·6 105	84·3 103	86·3 108	91·6 109	88·7 111	503 107	564
C	5 lb. sodium nitrate per tree	70·0 105	82·2 107	87·0 106	85·9 107	91·7 109	90·4 113	507 108	568
D	None	69·5 104	80·1 104	84·6 103	88·9 111	94·4 113	91·7 115	509 109	571

Series	Treatment in February 1928	1928 March	May	July	September	November	1929 January	Year 1928-1929 Lb. per acre	Kg. per H.A.
A	Control	57·3 100	65·5 100	91·9 100	104·7 100	96·6 100	106·7 100	523 100	586
B	4 lb. ammonium sulphate per tree	62·8 109	77·8 119	110·3 120	114·2 109	108·9 113	123·8 116	598 114	670
C	5 lb. sodium nitrate per tree	66·5 116	79·4 121	109·5 119	108·3 103	111·9 116	122·8 115	598 114	670
D	5 lb. sodium nitrate per tree	68·6 120	82·0 125	110·7 120	114·1 109	108·8 113	121·3 114	605 116	678

Series	Treatment in March 1929	1929 March	May	July	September	November	1930 January	Year 1929-1930 Lb. per acre	Kg. per H.A.
A	Control	77·0 100	83·3 100	96·5 100	89·9 100	82·4 100	80·0 100	509 100	571
	4 lb. ammonium sulphate per tree	84·0 109	100·6 121	111·8 116	107·1 119	99·1 120	98·6 123	601 118	674
C	5 lb. sodium nitrate per tree	81·0 105	96·9 116	111·2 115	103·3 115	92·6 112	96·1 120	581 114	651
D	None	77·6 101	92·0 110	108·4 112	107·6 120	97·1 118	91·8 115	574 113	643

LIBRARY
TNAU, Coimbatore - 3
000028135

FLUE-CURING OF TOBACCO*

Curing.—Correct curing is one of the most important steps in the production of flue-cured tobacco. The fact, however, must not be overlooked that unless fundamental principles, such as the right soil type, fertilisation, and variety, are given due consideration in the growing of flue-cured tobacco, no satisfactory cure can be expected. On the other hand, good quality flue-cured tobacco on the land may be completely ruined through negligence or carelessness in the operation of curing. The importance of curing cannot, therefore, be over-emphasized.

In the curing of flue-cured tobacco, however, no hard-and-fast rule can be offered. General principles can be laid down, but no formula as to temperatures and humidity can be given. The rate-of-curing temperatures and humidity to follow, naturally depend on the ripeness of the leaf, thickness and body, soil effect, climatic conditions, position of leaf on the plant, variety, and a number of other factors. Any formula given must, therefore, only serve as a guide, and must under no circumstances be accepted as correct for the curing of all flue-cured tobacco. Curing can best be learned only through practical experience.

Harvesting.—The correct harvesting of flue-cured tobacco has an important bearing on the success of the resultant cure. For the uniform curing of good quality tobacco, a first requisite is that the barn be filled the same day with leaves of uniform ripeness and character. The leaf must be fully ripe, but not over-ripe, as this causes it to be too brittle. Green leaves must not, under any circumstances, be picked, as they will cure green, black, or mottled, and are practically valueless. The importance of picking uniform, ripe leaves of the same character when filling the barn cannot, therefore, be over-stressed. If the leaves are not of the same ripeness and character, the yellowing and rate of curing in the barn will be uneven, with the result that some leaves will be yellow and ready for fixing, while others will still be green. The result is obvious: some will cure green.

Unlike air-cured tobacco, the leaves are primed off or picked as they ripen, from the bottom of the plant upwards. Generally, about four leaves per plant are picked at a time, depending, however, on the ripeness of the crop. From three to five pickings are necessary to complete the harvesting. To conform with this requirement, it is necessary to prime every week or every fortnight. If the crop is uneven or the ripening developed too far, it means that sand leaves, leaves from the middle of the plant and sometimes even tips, are cured in the same barn at the same time. This difference in the character of the leaf will result in a poor cure and subsequent loss. The necessity of growing a uniform crop of tobacco will therefore, be realised.

After picking, the leaves are placed on suitable receptacles which may be baskets or a box-like arrangement made from hessian sewn to a wooden frame. Both give satisfactory results. The basket consists of a wooden frame to which four grain bags, sewn together longitudinally are fixed. These containers are taken to the land, and the leaves are carefully placed in them. Great care must be exercised in handling the leaf, and in placing it in these receptacles, to avoid injury or its becoming sunburnt by too long exposure to the sun. Leaf damaged in this respect is practically ruined.

---

* **By W. R. Thompson, B.Sc. Agri. in *Bulletin* No. 88 of the Department of Agriculture of the Union of South Africa.**

When sufficient receptacles have been filled to fill a barn, they are carried to the stringing shed, or the picking and tying are carried on simultaneously in the lands. Except when weather conditions are unfavourable, the latter method is to be preferred. In this case, stringing is generally done in the shade of a tree if one happens to be near the land, or under a bucksail supported by poles. If this method is followed, it is best to have three or more baskets, so that while the one is being emptied, one is filled and the third is on its way to the stringing place.

In the United States of America, small trucks (sleighs) 2 feet by 6 feet by 4 feet high, hauled in between the tobacco rows by a mule while being filled, are commonly used for bringing the tobacco from the land to the drying place. Although this last method is the most efficient, any of the above, or any other method may be used in transporting the leaf, as long as it is not damaged, bruised, or allowed to become sunburnt. However, it must always be considered that the best method to employ is the one requiring the least labour.

Tying.—After the leaves have been brought to the stringing place, they are tied to a stick by means of ordinary thin twine. A string is tied to one end of a stick 4 feet 6 inches long (conforming to the tier poles in the barn) by 1 inch in diameter, and the leaves are tied to the stick in bunches of three to four, according to the size of leaf. The manner of tying these bunches (24 to 30 bunches per stick) is by means of a special twist or loop around each bunch in such a way that they hang alternately on each side of the stick. When the stick is fully loaded the free end of the string is tied to the other end of the stick. It is now ready to be hung in the barn for curing. In tying, some hand on the leaf in bunches of three or four to those tying. Generally from one to three labourers are required to hand on to each one tying. With practice, the process becomes easy and quick to perform. Three tying may easily fill a barn a day.

To allow for proper ventilation, it is best not to crowd the tobacco on the sticks, or the sticks in the barn. A standard barn 16 feet by 20 feet takes approximately 500 sticks and cures from 400 to 600 lb., depending on the tobacco.

Filling the Barn.—When the required number of sticks has been strung, the barn should be filled immediately and the tobacco not left in the stack for any length of time, as it may heat up and become damaged. The actual filling of the barn is easy. However, there are certain facts not to be overlooked. In the first place, it is desirable to fill the barn in one day or else the curing will not be uniform. Furthermore, when filling, crowding of the sticks is to be avoided, about 8 inches being allowed between them on the tiers, depending largely on the size and character of the tobacco. This is necessary for proper ventilation. Again great care must be exercised, in filling not to bruise or injure the leaf, as such leaf will not cure satisfactorily.

Barns.—To flue-cure tobacco successfully, it is essential to have an airtight barn with the necessary controlable top and bottom ventilators. The principle involved in the flue-curing of tobacco is to have complete and perfect control over the moisture condition and the temperature of the barn. It will readily be appreciated that if the barn is not airtight, with the necessary ventilation which may be increased or decreased as required, this purpose is defeated. In the United States of America, flue-barns are built of wood. In South Africa, where timber is expensive, they are built of brick. Walls constructed of burnt brick to a thickness of 14 inches, ensure a permanent structure.

There are two standard sizes of barn in use, viz: 16 feet by 16 feet by 20 feet high and 12 feet by 12 feet by 20 feet high. Both barns cure equally well. Where labour is a limiting factor in the filling of a barn, the one of 12 feet by 12 feet by 20 feet may be preferred, but when it is considered that the 16 feet by 16 feet by 20 feet barn does not cost correspondingly more, is probably more economical in fuel consumption, holds much more tobacco, and requires the same labour and trouble to cure, the 16 feet by 16 feet by 20 feet barn is to be preferred. The size of barn to be built, therefore, is to be decided in accordance with the circumstances and requirements of the farmer.

Furnaces.—Two types of furnace in use are the home-made brick furnace, and the patent furnace which may be used either for wood or coal. Both are satisfactory. The home-made, or ordinary brick-built furnace, owing to its cheapness of construction, is the one commonly used.

The furnace may be constructed inside or outside of the barn. Both have their advantages and disadvantages. The inside furnace dries the tobacco immediately above it a little faster while the outside furnace loses too much heat through radiation. Taking everything into consideration, however, the inside furnace is to be recommended as all the heat radiating from it is not wasted, but assists in drying the tobacco, thereby accomplishing a great saving in fuel.

The latest idea is to build the furnace rather long, low, and inside, with only a small part (approximately 1 foot) projecting. The other furnace is higher, shorter, and on the outside. In constructing the inside furnace in this way, little or no damage is done to the tobacco above it, while all the heat radiating from it is efficaciously used. Suitable dimensions (inside measurements) are 6 feet long by 18 inches wide by 12 inches to 18 inches high. Fire bricks or ordinary burnt bricks may be used. A fire grate is necessary, with fire bars preferably lengthwise. Anything that will not bend and which can stand a high temperature may be used. The ashpit is generally about 9 inches to 1 foot below the fire-box, which serves to collect all the ashes and reduced fuel consumption. A door for the furnace is highly essential, and in building the furnace it is best to use ordinary clay, as cement tends to crack as soon as it is subjected to a high temperature.

Whether one or two furnaces are to be used per barn depends on its size and whether it is inside or outside. In a 12 feet by 12 feet by 20 feet barn, one furnace in the centre is ample. In a 16 feet by 16 feet by 20 feet barn, one or two may be advantageously used. Two probably give a better distribution of heat, but are probably not as economical in fuel as where one is used.

Flues.—Circular flues of 10 inches to 12 inches in diameter are mostly used, so that the flue may be arranged inside the barn. The flue systems mostly used in conjunction with single and double furnaces are illustrated in the blue prints. There are several home-made flues which may be constructed cheaply and with good results. Whatever system is used, it should be arranged in such a way that the heat is evenly disrtibuted in the barn. The flues are elevated and inclined upwards throughout their lengths, to obtain the correct draught. They generally pass out through the barn wall into the chimney at a point 1 foot to 1½ foot higher than the mouth of the furnace. It is most important to have the correct draught. The chimney may be built of brick, or flues may also be used for this purpose. To ensure a good draught, it must project above the roof.

Ventilation.—In order to have complete control over the temperature and humidity of the barn, an efficient system of ventilation is necessary. The ventilation system consists of top and bottom ventilators which may be

completely controlled, that is, opened or closed as required. The greenhouse or ridge type of the top ventilator along the entire length of the barn is best. Four bottom ventilators are sufficient, and if they enter the barn below the flue no cold air suddenly enters the barn. Without proper ventilation no success in curing can be obtained.

The Curing Process.—Immediately after the barn has been filled, small fires are started in the furnace, either wood or coal being used, depending on what is the most economical under the circumstances. About one to one and a half cords wood (4 feet by 4 feet by 8 feet), or approximately 10 bags of coal are required to cure a standard barn under satisfactory conditions.

The flue-curing process involves three important stages, viz:

(1) The yellowing of the leaf.
(2) Fixing the colour.
(3) Drying the leaf.

In South Africa, with a comparatively dry climate, yellowing of the leaf without a limited application of artificial moisture in the barn is sometimes difficult, except where yellow, light-coloured, and thin bodied tobacco is cured, such as, for example, Amorelo, or where tobacco grown on very poor soil is cured. For the yellowing of good-bodied tobacco, a limited degree of moisture is necessary in the early stages, depending upon climatic conditions and certain other factors. There are various ways by which this required moisture may be applied, such as, for example, by steam, wetting the floor, or by suspending wet bags above the flues on a 3-foot wire netting. The last method is the most practical, gives satisfactory results, and is to be preferred. The wire netting above the flues also catches any dry leaves which might fall off on to the hot flues, and so reduces the risk of fire. Moreover, if wet sand is used, or if the walls and floor are moistened, it is impossible to get rid of the moisture quickly enough when so desired, with the result that the leaf sponges, that is, the moisture condenses on the surface of the leaf, causing it to burn black or a grey, dirty colour, which is undesirable and considerably reduces it value. This is commonly known as sponging. Wet bags can be easily removed, and the barn thus freed quickly of the excess of moisture, when so desired.

After the barn has been filled, all ventilators are closed, the necessary moisture is put in, if required, and a thermometer (preferably a wet and dry bulb, so that both temperature and humidity of the barn can be read), hung level with the tobacco of the bottom tier and in the centre of the barn.

A small fire is now started in the furnace, and the yellowing of the leaf commences. There should be sufficient moisture in the earlier stages of yellowing to prevent the leaf from drying, and the best means of accomplishing this is by means of an airtight barn.

The temperature should be raised to 80°F., and kept between 80° and 100°F. until the leaf is practically yellow. The temperature should be raised very slowly from 80°F. to 100°F., possibly 5° every ten or twelve hours, to allow the leaf time to yellow. When the tobacco yellows rapidly, the temperature may be raised faster. On the other hand, if yellowing is slow, more time is required. Judgment by the curer is necessary to decide this question. Under average conditions, the yellowing will take from 36 to 54 hours, and sometimes even longer. However, the yellowing period will depend largely on the variety of tobacco, thickness of body, ripeness, soil type, and climatic conditions.

When artificial moisture is supplied by use of wet bags, it must be removed some time before the yellowing is completed, that is, somewhere around 95° to 100°F. The difference between the wet and dry bulb thermometers should now be approximately 8°F., while it should register a difference of from approximately 3°F. in the beginning and a higher difference as the yellowing proceeds.

When the yellowing is pronounced, the temperature is gradually raised to 105° and 110°F. At this stage, the leaf should still have a slight greenish tinge, as the yellowing continues to some extent until around 120°F.

The next step is fixing the colour, and is the most critical period in the process. The moisture is removed, gradually at first, by opening the top ventilators, and a little later also the bottom ventilators, increasing the ventilation slowly until all the ventilators, (both top and bottom) are fully open. Care must be taken to avoid drying the leaf too rapidly, but as it begins to yellow, the humidity in the barn must be diminished by slowly raising the temperature and gradually increasing the ventilation; that is, the moisture is removed as it escapes from the leaf. Never allow the temperature to drop, as this will retard the drying and spoil the leaf. The temperature is now slightly raised to 120° and 125°F. At this stage, the tips of the leaves will begin to dry and curl upwards. Later, the temperature is further gradually advanced to 130° and 135°F. and kept there until the leaf web and small veins are dry. It should not exceed 140°F. before the web is dry. This stage of curing is known as drying the leaf.

All danger from sponging or scalding is now over, and it will be necessary only to dry the mid-ribs. At this stage, the ventilators are again nearly closed at first, and completely later, while the temperature is raised 5°F. every two hours until 160°F. is reached, and maintained at this level until the stems are thoroughly dry. It is best not to exceed this temperature, as it causes the leaf to become too brittle; it may also impair the colour and greatly increase the risk of fire. To ascertain when the mid-ribs are dry, the tobacco is examined in the corners and sides of the barn, where drying is slower. Never stop firing until the mid-ribs are thoroughly dry. As soon as the mid-ribs snap between the fingers, the curing is complete, and the door and ventilators may be opened to allow the barn to cool. Normally, the curing process takes from five to six days.

During the curing, the heat should not be allowed to fluctuate too much; temperatures should be kept as constant as possible, and when necessary to raise them, it must be done gradually. Once curing is commenced, fires are kept going day and night.

When the barn has cooled down, a small fire is made in the furnace and wet bags placed over the flues to bring the tobacco to the condition in which it can be removed from the barn without breaking and damaging the leaf. The tobacco is now ready to be graded and marketed.

Formula for Curing.—The impossibility to offer a definite formula for the curing of all tobacco is obvious, for it depends entirely on the character of the leaf, climatic conditions, and many other variable factors. For reasons enumerated above, the following formula is given only to serve as a guide, and must not be applied as a hard-and-fast rule. It is good judgment and discretion in each cure that matters more than anything else, and there may sometimes be great divergences from the times and temperatures given below:—

I.—YELLOWING THE LEAF

Wanted	Temperature (Degrees F)	Time (Hours)	Remarks
Leaf yellow round edges ...	85-90	12-24	Sometimes even longer
Yellow to spread ...	95	8-14	
Yellow more pronounced ...	100	7-9	Open top ventilators slightly.
Yellow more distinctly ...	105	6-12	Open top ventilators slightly more. Open bottom ventilator slightly.
Practically Yellow ...	110	6-8	Open top ventilators. Open bottom ventilator more.

II.—FIXING THE COLOUR

(When practically yellow, start fixing the colour.)

Temperature	Time (Hours)	Remarks
115°F.	5-7	All ventilators fully open.
120°F.	6-7	Ventilators open.
125°F.	5-7	
130°F.	6-8	

III.—DRYING THE LEAF

Temperature	Time (Hours)	Remarks
135°F.	5-8	
140°F.	3-5	

IV.—DRYING THE MID-RIB

145°F.	2	
150°F.	2	
155°F.	2	
160°F.	12	(Or till dry)

Note.—If artificial moisture be used, remove at approximately 95°F to 100°F.

Open ventilators gradually from 100°F. to 115°F.

Close ventilators when drying the mid-ribs.

Handling and Grading.—In general principle, the handling and grading of flue-cured tobacco is similar to that of air-cured. The sticks are removed from the flue-barn after it has been conditioned as explained above, and bulked on the sticks in a suitable dry room. Care must be taken not to bulk the tobacco in too high condition, as this will cause an undue rise in temperature, and these are optimum conditions for mould growth. Inspect the tobacco occasionally to determine whether there is any such danger.

It is good practice to keep the tobacco of each barn separate, as this will greatly facilitate grading, in that there should only be a limited number of grades. The tobacco cured in successive barns generally comes from certain positions on the plant, and is, consequently, fairly uniform. Moreover, it is best to grade as soon as the barn is cured, for this eliminates the danger of keeping it in stacks for any length of time. Also the same sticks and string can repeatedly be used during the curing season, and reduces the capital outlay and the cost of production.

In grading, leaves of the same quality, that is, body, texture, colour length, width, soundness, etc., are sorted together. Trashy, damaged, green leaves and tips should be sorted into separate grades.

After the tobacco has been graded, it is tied into hands and baled in the usual way. Again, great care must be exercised not to bale the leaf in too high condition, as this might cause severe loss. The hands must be baled with the butts outwards, the bales being well protected on the sides and covered with hessian or old grain bags, to prevent damage.

Flue-cured tobacco is an expensive, high-priced, and delicate article, and certainly requires much skill and attention during all its processes of production, if good results and high prices are to be obtained. The personal element, however, plays an important role, and it depends largely on the farmer himself, other factors being equal, whether substantial profits are to be made. If the curer is careless and neglects some of his duties in the production, curing, and handling of flue-cured tobacco, great losses may be suffered, and his margin of profit turned into loss.

PRODUCTION OF WHALE OIL*

THE increasing production of whale oil as well as groundnuts and other oil seeds and nuts has an important bearing upon the copra position. This fact has been explained in an article which appeared in this Journal in February, 1930, and also in a report prepared by the Empire Marketing Board which was published in *The Tropical Agriculturist*, March 1930.

The steady increase in production shown below is further emphasised by the fact that the average annual production of whale oil between 1910-1920 was about 550,000 barrels.

The trade estimate of the quantity of whale oil coming on the market in recent years is as follows:

Year			Barrels
1925	...	...	1,044,272
1926	...	...	1,166,857
1927	...	...	1,220,415
1928	...	...	1,356,308
1929	...	...	1,861,877

The quantities produced have been greatly increased in recent years on account of the great improvement in the methods employed in the whaling industry. Although no estimate is available of production in 1930, it is expected that heavy catches will continue unless they should result in too drastic depletion of the herds.

Owing to modern methods of treatment, a proportion of the oil can be made up into a non-odorous fat suitable for human consumption, but it is not possible to say what proportion of the whale oil available for world consumption is rendered available for edible purposes.

The following brief history of whaling and its future, was delivered by Professor A. C. Hardy in a recent wireless "talk."

Every whale fishery has followed the same course—first a period of rapid development and profitable enterprise followed by collapse and final failure. By the fifteenth century the Basques had exterminated the Nordkarper whales from the Bay of Biscay—in the sixteenth century the Newfoundland fishery rose and fell. Then the Greenland whale was discovered and from the beginning of the seventeenth century to the middle of last century a series of fisheries one after the other flourished and failed, first round the coast of Spitzbergen and Jan Mayen Land in the days of great competition between the English and the Dutch and then at Greenland and far up the Davis Straits to Baffin Bay. One by one the great British whaling ports gave up. Hull, once famous for its whaling, sent its last ship in 1869—and a few ships still sailed from Dundee till the beginning of the present century.

Just when it seemed that whaling in the north was dead, Svend Foyn, a Norwegian, in 1865 invented the modern harpoon gun. This opened up a new fishery, that of the great rorqual whales which had hitherto been too fast and powerful to be attacked. Then history repeated itself once more and for many years now only a few small stations have been operating in the north. It seemed that whaling was passing altogether from the world—but no.

* From *The Malayan Agricultural Journal*, Vol. XVIII, No. 12, December, 1930.

Reports brought back by expeditions from the Antarctic showed that there were whales in the far south. In 1904 that great Norwegain whaling Captain—C. A. Lansen—established the first whaling stations in the south of South Georgia. In the following year floating factories visited the South Shetlands still farther south. So successful were these enterprises that by *1912* there were twenty-one whale catchers working in South Georgia and thirty-two in the South Shetlands. All these islands are part of the British Empire, being Dependencies of the Falkland Islands. The Government, realising the danger to the industry, limited the number of licenses issued to the companies; but during the war when the oil became of great importance the restrictions were relaxed, and in 1915-16 the number of whales taken in a single season reached close on 12,000. If further regulations should become necessary to save the industry from decline, it was realised that it must be based on scientific knowledge. A Committee was set up with the result that the "Discovery" investigations were planned and are now being carried into practice under the leadership of Dr. Stanley Kemp. We knew practically nothing about the biology of these great whales, about their breeding habits, migrations, length of life, the time they take to reach maturity, and of the factors underlying the fluctuations in numbers from year to year. Knowledge of all these points and many others is of the utmost importance. Dr. Kemp and his staff are busy finding the answers to these questions, and much valuable information has already been obtained *and is being published in the "Discovery" reports.*

In the meatime new developments have taken place in the industry. Hitherto this whaling has been confined to shore stations of floating factories which must be anchored in the shelter of the land. A floating factory ship carries out all the operations just described, within her hull. The whales are flensed and cut up alongside—hence the necessity for calm water. But now in recent years a new type of floating factory has been evolved—it is known as a pelagic whaler, because it can carry out operations in mid-ocean. Huge jaw-like gates open in the bows or stern, revealing a sloping gullet from the sea up to the deck. The whales brought in taken by the catches are swallowed whole. "Surely," as some journalist has aptly said "This is Jonah avenged."

Whaling can thus be carried out without complying with local regulalations, The number of whales being taken in the Antarctic is increasing every year; some fortythousand were killed during last season. The regulation of the industry of the future must depend upon international agreement, which is inevitably slow. Let us hope that it will come before it is too late. We need not fear the complete extermination of whales, because the industry is now carried out upon such a scale that it must fail before the whales are actually brought to extinction. But there is a very real danger if care is not taken, of a collapse of the industry, with the loss of this valuable supply of oil if not for ever, for a very long time to come.

HOME MIXING OF FERTILIZERS

COMMERCIAL fertilisers are usually mixtures of materials containing nitrogen, phosphoric acid and potash. These so-called complete fertilizers may be bought ready mixed, or the ingredients may be bought and mixed on the farm. The fertilizer industry in this country is based largely on factory-mixed goods, but the practice of home mixing has always had its advocates.

For one thing, home mixing is often more economical and affords the farmer an opportunity to prepare fertilizer mixtures adapted to special needs. The farmer not only learns more about fertilizer materials but can select them himself. In many cases it is important to know what form of nitrogen to use. For example, for some crops a large proportion of a quick-acting nitrogen carrier is essential; for others a more slowly acting one, which allows the nitrogen to become available gradually throughout the season, is desirable. The home mixer can, for example, purchase sodium nitrate or ammonium sulphate and be certain that he is obtaining high-grade materials.

In some localities, the farmer has a chance to buy so-called open formula mixed fertilizers. The company states plainly the ingredients used in making the fertilizer and the pounds of each ingredient in a ton of the mixed product. This system of selling takes away one of the reasons for farmers prefering to do home mixing.

Undoubtedly home mixing is a good thing for many farmers, both financially and educationally, and should be considered where economy is necessary or desirable. Usually, where only a small amount of fertilizer is to be used, it is more convenient to buy commercial mixtures. Such mixtures may also be best adapted to the needs of the farmer who does not have the facilities for home mixing or who is not in a position to study the subject. Home mixing, however, has proved satisfactory in many parts of the country. The mixing materials commonly used are given in Table I.

* From *Leaflet* No. 70 of the United States Department of Agriculture.

Table 1—Composition of the principal commercial fertiliser materials:

Fertilizer material	Nitrogen	Phosphoric acid	Potash
Supplying nitrogen:	per cent.	per cent.	per cent.
Nitrate of soda	15·5-16·0	—	—
Sulphate of ammonia	19·0-20·5	—	—
Dried blood (high grade)	12·0-16·0	—	—
Dried blood (low grade)	10·0-11·0	3·0- 5·0	—
Concentrated tankage	11·0-12·5	1·0- 2·0	—
Tankage (bone)	5·0- 6·0	11·0-14·0	—
Dried fish scrap	7·0-10·0	6·0- 8·0	—
Cottonseed meal	6·5- 7·5	1·5- 2·0	2·0- 3·0
Castor pomace	5·0- 6·0	1·0- 1·5	1·0- 3·0
Calcium cyanamide	19·0-22·0	—	—
Urea	46·0	—	—
Supplying phosphoric acid:			
Steamed bone meal	1·0- 2·5	22·0-30·0	—
Ground bone (raw)	2·5- 4·5	20·0-25·0	—
Superphosphate (acid phosphate)	—	16·0-20·0	—
Treble superphosphate*	—	40·0-45·0	—
Basic slag	—	13·0-18·0	—
Raw ground phosphate rock	—	26·0-35·0	—
Ammonium phosphate	11·0-21·0	20·0-61·5	—
Supplying potash:			
Potassium sulphate	—	—	48·0-52·0
Potassium muriate (chloride)	—	—	48·0-60·0
Potassium nitrate	13·0	—	46·0
Kainit	—	—	12·0-16·0
Manure salts	—	—	20·0-30·0
Sulphate of potash-magnesium	—	—	25·0
Wood ashes	—	1·0- 2·0	2·0- 8·0
Dried sheep manure	1·51-3·09	·95-2·50	·33-2·24

* Also called double superphosphate.

PURCHASING FERTILIZER MATERIALS

In the purchase of fertilizer materials good business judgment should be used. Wide competition should he sought and prices procured not only from local merchants but from large fertilizer firms. Advice should be sought from the country agent. Best prices can be obtained for cash. Materials should be bought well in advance as this not only insures a better price but allows the use of farm labour in the winter when it is often not occupied profitably. Home mixing may be done in the barn when weather is too inclement for outside work.

MIXING COMMERCIAL FERTILIZERS

The mixing of the materials is comparatively simple. Any tight floor or a wagon box may be used, and tools at hand may be employed. The materials are spread in layers, usually the most bulky first, and are thoroughly shoveled together. The mixture is passed through a screen, and any lumps present are broken up with a tamper or the back of a shovel. The author has found a very large long-handled mortar hoe a convenient tool for mixing, but its purchase especially for this purpose is not necessary. Where large amounts, are to be mixed it would probably pay to buy a rotary mixer such as is sold for concrete mixing on the farm. The stirring should be continued until the materials are uniformly mixed and show no streaks of colour, after which the product may be bagged and stored in a dry place until applied.

To avoid caking and losses of plant-food elements, certain ingredients should not be used together in a mixture.

When taking high-analysis mixtures with concentrated materials it is well to include at least 100 to 200 pounds per ton of the mixture of some organic material, such as fish scrap, animal tankage, or cottonseed meal as a conditioner. This holds good especially when the mixture is to be stored.

One of the earliest ways to start home mixing is to duplicate a formula already in use. A beginner should select a mixture which has been successfully used on similar soil on the crop he intends to raise, get a price on the mixed goods, and then find out what a home mixture of similar analysis will cost.

In making up fertilizer formulas it is well first to decide what percentages are required and then what materials shall be used. Start with the phosphoric acid (P_2O_5). Superphosphate is almost universally used as a source of the phosphoric acid in ordinary strength fertilizers. With 16 per cent. goods if 8 per cent. of phosphoric acid is desired in the mixture, the procedure would be as follows: If the whole mixture were superphosphate, it would contain 16 per cent. of phosphoric acid; as 8 per cent. is desired, make eight-sixteenths (one-half) or 1,000 pounds of the mixture superphosphate; if 6 per cent. is wanted six-sixteenths or 750 pounds to a ton would consist of this material. Similarly with nitrogen, if nitrate of soda contains 15·65 per cent. of nitrogen and 2 per cent. nitrogen is desired, 2/15·65, or approximately one-eighth of the mixture or 250 pounds in a ton, will be needed. Similarly with potash, if potassium chloride containing 50 per cent. of potash is used and 5 per cent. potash is desired, five-fiftieth or one-tenth of a ton of potash (200 pounds) is needed.

Any other material may be used in a similar manner. It is not necessary for the farmer to be exact down to the fraction of a per cent. as fertilizer application is not an exact science and a slight variation in the calculation will not alter materially the agricultural value of the mixture.

Fertilizer materials are often used to advantage without mixing. Examples are superphosphate, basic slag, nitrate of soda, and sulphate of ammonia.

Table 2 will be of help in calculating home mixtures. In making ton lots, to get 1 per cent. use amounts shown in the first column; for 2 per cent. use those in the second column, and so on.

Table II.—*Quantities of fertilizer ingredients to be used to give definite percentages in a ton of mixture*

Ingredient	1 per cent	2 per cent	3 per cent	4 per cent	5 per cent	6 per cent	7 per cent	8 per cent	9 per cent	10 per cent
	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
Carriers of nitrogen (N):										
Nitrate of soda (15 per cent N)	133	266	400	532	666	800	933	1,066	1,200	1,333
Sulphate of ammonia (20 per cent N)	100	200	300	400	500	600	700	800	900	1,000
Cottonseed meal (7 per cent N)	285	571	856	1,142	1,428	1,714	2,000	—	—	—
Dried blood (10 per cent N)	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Fish scrap (8 per cent N)	250	500	750	1,000	1,250	1,500	1,750	2,000	—	—
Carriers of phosphoric acid (P_2O_5):										
Superphosphate (16 per cent P_2O_5)	125	250	375	500	625	750	875	1,000	1,125	1,250
Superphosphate (20 per cent P_2O_5)	100	200	300	400	500	600	700	800	900	1,000
Double superphosphate (40 per cent P_2O_5)	50	100	150	200	250	300	350	400	450	500
Ground bone[2] (23 per cent P_2O_5)	87	174	261	348	435	522	609	696	783	869
Carriers of potash (K_2O):										
Potassium sulphate (50 percent K_2O)	40	80	120	160	200	240	280	320	360	400
Potassium chloride (50 per cent K_2O)	40	80	120	160	200	240	280	320	360	400
Kainit (12.5 per cent K_2O)	160	320	480	640	800	960	1,120	1,280	1,440	1,600
Manure salts (20 per cent K_2O)	100	200	300	400	500	600	700	800	900	1,000

[1] Where the combined material do not total 2,000 pounds, a filler may be used to bring up the mixture to that weight.

[2] Ground bone also carries nitrogen.

EXAMPLES

To make up a ton of a 4-8-4 mixture in which the nitrogen is one-third ($1\frac{1}{3}$ times 133 pounds = 178 pounds) in the form of nitrate of soda, one-third in the form of sulphate of ammonia, and one-third in organic form from cottonseed meal, the phosphoric acid is from 16 per cent. superphosphate, and the potash is from 50 per cent. potassium chloride (also known as potassium muriate), the following materials would be used:

			Pounds
Nitrate of soda	...	...	178
Sulphate of ammonia	...	...	134
Cottonseed meal	...	...	380
Superphosphate (16 per cent.)		...	1,000
Potassium chloride	...	...	160
Filler *(ground dried peat)*	...	...	148
Total	...	...	2,000

Since the fertility materials add up to 1,852 pounds, 148 pounds of a filler is added. This filler may be a conditioner as well and often has some fertilizer value in itself. Dried peat ground phosphate rock, ground limestone, or even sand may be used. The total is so near 2,000 pounds that it may be considered unnecessary to bother with a filler. When the total of the mixture is appreciably less than 2,000 pounds, it may be perfectly satisfactory to use a smaller quantity of fertilizer per acre rather than to dilute with filler. Thus, if you are making a ton of 4-8-4 mixture, in which the sum of the materials used is 1,500 pounds without filler, by using three-fourths of the normal application, the filler can be omitted.

The mixture just given is a good general fertiliser. Its nitrogen is in different degrees of availability. The cottonseed meal in this mixture, besides its fertilizer value, is an excellent conditioner.

A HOME FOR EMPIRE INSECTS*

"ROGUES' GALLERY" FOR THE KING'S SIX-LEGGED ENEMIES

BOXES OF BEETLES

SIX million insects have "moved house" into the new wing built by the Empire Marketing Board at the Natural History Museum, which was opened recently by the Archbishop of Canterbury. Acute over-crowding in the insect rooms, which contain specimens from every corner of the world has made necessary a new building for their display.

The collection is a sort of "rogues' gallery" for the use of the men who are policing the Empire's most destructive and dangerous criminals —the insect pests. If a new insect crook tries to put an Empire crop "on the spot" the entomologist's first act, like the detective's, is to identify the pest and to get its dossier from the criminal records. This information tells him the criminal's habits and methods of working and helps him to find ways and means of outwitting the enemy.

INSECT GENERAL POST

Farmers, medical officers, missionaries, commercial men, and agricultural specialists send specimens to be identified from all parts of the Empire. By every morning's post arrive boxes containing an unknown beetle from the West Indies, a moth which is ruining crops in Fiji, an ant which lives on railway sleepers in Palestine, or a fly suspected of carrying some fatal disease in Central Africa. These are filed in special wooden specimen cases and scientists study such delicate signs as the insect's lower jaw or the pattern of the veins on its wing to find its exact place in the tribe.

Advice on practical control measures, also, is given. The new building contains "controlled temperature" rooms where the insects can be reared under tropical conditions even in an English winter. Their life-histories can then be studied and certain methods of destruction tested.

TWO STRANGE COLLECTORS

Three-quarters of a million butterflies are arranged in one of the new rooms and have a romantic history. Two brothers who lived near Rheims, in France, collected insects as a hobby. One devoted himself to beetles; the other collected butterflies, and by the end of his life had amassed one million specimens. When the collection came up for sale the Natural History Museum acquired the bulk of it. Then the butterflies, the most fragile of cargoes, had to be transported to London. They were taken across France by road, shipped with tender care over the Channel and finally delivered in South Kensington in thirteen specially padded vans.

* Empire Marketing Board Publication, 1930.

Other insects have reached the Museum in odd ways. A bookseller bought an ancient cabinet of books in which he found a number of dead butterflies. They turned out to belong to an old English species which had since become extinct and to be worth ten guineas each. They now repose in the new insect wing. Attempts have been made to re-introduce several species of butterflies which had become extinct into butterfly sanctuaries in East Anglia.

MOTHS FROM AN OIL-FIELD

Some other valuable moths were collected by an engineer on a South American oil-field. "The desire of the moth for the flame" drove them to beseige his flares when he was working at night. Other specimens have been sent in by army officers who take up "bug-hunting" in their spare time in Iraq, Egypt, Aden, and the Frontier.

The insect wing will provide room for scientists from overseas who wish to work at the Museum. Nowhere else in the Empire can they find so complete a collection, and the new accommodation should prove another valuable weapon in the war against insect pests, for which the Empire Marketing Board has already allocated some £200,000. The Natural History Museum does for insects much what Kew does, through its Herbarium, for the plant world.

MEETINGS, CONFERENCES, ETC.

BOARD OF AGRICULTURE

Minutes of a meeting of the Board of Agriculture held in the board-room of the Department of Agriculture, Peradeniya, at 2 p.m. on Monday, October 20, 1930.

His Excellency the Governor, President of the Board of Agriculture, presided.

The following members were present:

The Director of Agriculture; Sir Solomn Dias Bandaranaike, K.C.M.G.; Mr. C. W. Bibile; Mr. J. P. Blackmore; Mr. R. G. Coombe; Mr. H. L. de Mel, C.B.E.; the acting Director of Irrigation; Mr. Chas. A. M. de Silva; Mr. Wace de Niese; Mr. F. R. Dias; the Divisional Agricultural Officers, Central, Southern, South-Western and North-Western Divisions; Mr. C. Drieberg; the Economic Botanist; the Entomologist; the Hon'ble Sir Marcus Fernando; Gate Mudaliyar G. A. Goonetilleke; the Government Agent, North-Western Province; the Hon'ble Mr. D. H. Kotalawala; Mr. D. J. Malcomson; the Manager, Experiment Station, Peradeniya; the Hon'ble Mr. T. B. L. Moonemalle; Mudaliyar S. Muttutamby; Mr. C. Muttyah; the acting Mycologist; Mr. Graham Pandittesekera; Mr. S. Pararajasingham; Gate Mulaliyar A. E. Rajapakse; Mudaliyar M. S. Ramalingam; Mr. L. F. Roundell; the Hon'ble Mr. D. S. Senanayake; Mr. N. D. S. Silva; Mr. Rolfe Smerdon; Adigar W. A. Udugama; Mudaliyar S. M. P. Vanderkoen; Mr. T. Wallooppillai; Mr. A. A. Wickremasinghe; Rev. Fr. L. W. Wickremasinghe; Mr. Huntley Wilkinson; Mr. J. I. Gnanamuttu (Secretary).

Visitors: Mr. C. V. Brayne; Mr. A. M. Clement Dias; Mr. S. J. F. Dias; Mr. Reginald M. Fernando; Mr. N. K. Jardine; Mr. C. N. E. J. de Mel; Mudaliyar R. C. Proctor; Mudaliyar C. Rasanayagam; Mudaliyar N. Wickremaratne.

Letters and telegrams regretting inability to attend the meeting were received from the following: Mr. L. G. Byatt; Mr. J. Carson Parker; Mr. J. Horsfall; Dr. T. B. Kobbekaduwa; Mr. D. B. Moeran; Mr. Sheridan-Patterson; Mr. A. W. Reid; Mr. A. T. Sydney Smith; Mr. J. H. Titterington.

AGENDA ITEM No. 1.—MINUTES

The minutes of the meeting held on February 20, 1930, copies of which had been circulated to members, were taken as read and were confirmed and signed by the President.

AGENDA ITEM No. 2.—NOMINATIONS TO COMMITTEES

On the motion of Sir Marcus Fernando, seconded by Mr. Wace de Niese, the meeting approved of the following appointments to fill the places of members who had gone on leave, or to fill vacancies created by resignations:

ESTATE PRODUCTS COMMITTEE

Lieut.-Colonel G. O. Hunt, in place of Lieut.-Colonel J. A. M. Bond, resigned.

Mr. L. G. Byatt, in place of Mr. G. L. H. Doudney, resigned.

Mr. J. Carson Parker, to act for Mr. J. W. Ferguson, on leave.

Mr. D. B. Moeran, to act for Mr. A. W. Ruxton, on leave.

Mr. D. J. Malcomson, to act for Mr. C. C. du Pré Moore, on leave.

Mr. Rolfe Smerdon, to act for Mr. B. M. Selwyn, on leave.

FOOD PRODUCTS COMMITTEE

Rev. Fr. L. W. Wickremasinghe, in place of Mudaliyar S. P. Wijetunge, transferred from Hambantota.

AGENDA ITEM No. 3.—AMENDMENT OF RULES

Mr. T. H. Holland moved that rule No. 2 of the rules framed under Ordinance No. 37 of 1921 be amended, substituting the Tuesday before the second Wednesday, for the holding of meetings of the Estate Products Committee, instead of the second Thursday of the months of January, March, May, July, September and November. Mr. Holland explained that the amendment was in consideration of the fact that the general committee meetings of the Planters' Association of Ceylon were held on the dates now suggested. Mr. C. A. M. de Silva seconded the motion, which was carried.

AGENDA ITEM No. 4.—RESOLUTION OF PADDY CULTIVATION

Mr. H. L. de Mel, C.B.E., proposed the following resolution which had been formulated by a Sub-Committee of the Food Products Committee appointed for the purpose of taking action on the Reports of the Local Committees.

That a Commission be appointed by Government to enquire into and make recommendations with regard to the possibility of increasing paddy production in the Island in the light of information in the reports submitted to the Food Products Committee by District Sub-Committees, especial attention being given, amongst other points, to the following:

(1) Improvement of irrigation facilities so as to meet the needs specified in the reports.

(2) Organisation and co-ordination of the services concerned with the cultivation of paddy, as Agriculture, Irrigation, Revenue, Forestry, Animal Husbandry and any others (here should be considered provision of pasturage and fencing).

(3) Tenancy conditions (consolidation of infinitesimal shares in land, alienation of new lands under such conditions as to prevent the system of infinitesimal shares, and the impediment of the existing share system of rental.)

(4) The marketing question (credit, supply of seed paddy and manure).

(5) Anti-malarial and other public health measures.

(6) The improvement, where necessary, of means of communication.

(7) Provision of efficient drainage and flood protection, including the clearing of elas.

Mr. de Mel explained at length how the present recommendations had emanated from a resolution passed at the Agricultural Conference of May 1928, as a result of which Local Committees had been formed to investigate the question of paddy cultivation in all its aspects in their district and to report to the Food Products Committee. Those reports, together with a synopsis of them were now in the hands of the members. He thought that an unofficial body like the Food Products Committee could only make a recommendation to Government and that the details should be considered by a Commission to be appointed by Government.

In seconding this resolution Mr. C. Drieberg urged the necessity of closer co-operation between the Departments which are concerned with rural economy and hoped that with such co-operation it would be possible to make paddy cultivation a national industry such as it is in Japan.

The Hon. Mr. D. S. Senanayake opposed the resolution as in his opinion no useful purpose would be served by the appointment of a Commission, which being not an administrative body, could only submit a report. He suggested that the Director of Agriculture could establish a close association with the Treasury and other Government Departments and give effect to the recommendations before them.

His Excellency said that, without a desire to influence the decision of the Board, he thought that if a Commission were appointed it would have to include representatives from other departments so that all the questions involved in the inquiry would receive due consideration. If the matter were referred to the Director of Agriculture it would obviously be necessary for him to consult other departments and set up an inter-departmental committee presided over by himself. The difference between that and a Commission was that on a Commission the official representatives would have the advantage and benefit of unofficial colleagues who would bring to bear their local knowledge and experience which might not be available to a departmental committee.

Mr. C. V. Brayne remarked that a Commission with terms of reference such as the one proposed would be overloaded. Four or five distinct and different subjects were involved and the proposed Commission would probably have to be as large as the Land Commission. If the work was to be done expeditiously and efficiently a small body of 3 to 4 members was the ideal. With regard to item (2) of the resolution, the organisation and co-ordination of the services concerned with the cultivation of paddy would automatically happen under the New Constitution and he doubted the usefulness of a Commission anticipating that event.

His Excellency suggested that the difficulty contemplated by Mr. Brayne could be averted by the Commission dividing itself into sub-committees to deal with the various groups of subjects. This was done with good results by the recent Colonial Conference in London, upon which he was and, although they were a very large body, they had dealt with a considerable variety of subjects. In the same way, if they appointed a Commission, the best way for it to conduct its operations would be to divide itself into sub-committees, the main Commission acting as a co-ordinating and general advisory body.

The Colonial Secretary observed, in reply to further remarks by Mr. Senanayake, that the Commission would be in a position to recommend to Government the order in which the desirable works ought to be taken up as the money became available. He suggested as a formal amendment the substitution of the words "the Government be requested to appoint a Commission" for the words "that a Commission be appointed."

His Excellency the Governor added that the Commission could adopt very much the same procedure as that followed by the Public Works Advisory Board.

The Hon. Mr. W. A. de Silva stated that it would be three years before the Commission concluded its labours, such was the case with the Landless Villagers Commission and others. He thought that if the Director of Agriculture would go into the recommendations of the sub-committees and place his own proposals before Government some definite policy could be initiated. It was necessary that whatever was to be done should be undertaken without delay. This view was supported by Mr. A. A. Wickremasinghe.

Mr. L. Lord pointed out that the recommendations of the Food Products Committee were of necessity made with a view to their consideration by a responsible Commission. They were by the conditions under which they were compiled of necessity incomplete. The sub-committees had not had the benefit of the views of Irrigation and Revenue Officers.

Mr. T. Wallooppillai supported the resolution.

Sir Marcus Fernando thought that only a Commission could judge between the recommendations that were essential and those that were not. He feared that the adoption of the recommendations in their entirety was out of the question. If action on all were attempted at once the entire resources of the Island would be required to carry them out. To the most important effect should first be given. He agreed with Mr. Brayne that the question of co-ordination of the services, equally with that of anti-malarial measures, should be eliminated from the deliberations of the Commission. He supported the appointment of a Commission because he thought that a start must be made without further delay.

On the invitation of the President, the Director of Agriculture said that, if he was to undertake the work single-handed, he would have to ask permission to form a Commission himself. In the matter of water supply he would have to consult the Director of Irrigation; in regard to transport facilities the Railway authorities; and in regard to marketing the Co-operative Department. A Commission armed with the authority of Government was necessary. He had had no part in the recommendation that a Commission should be appointed, but he was very glad when the Food Products Committee took that line.

The resolution was then put to the House and was carried, 36 voting for and 3 against.

The suggested terms of reference were then put *seriatim* and were carried, with the exception of items (2) and (5) which were deleted.

At the suggestion of Mr. A. A. Wickremasinghe the subject of rural agricultural education was accepted for inclusion in the terms of reference to the Commission.

The Colonial Secretary suggested that item (6) means of communication, might be included under the same sub-head as the marketing question.

His Excellency concluded this discussion by stating that the exact terms of reference would be re-drafted in due form.

AGENDA ITEM No. 5.—THE CULTIVATION OF LARGE AREAS OF PADDY BY GOVERNMENT

Attapattu Mudaliyar W. Samarasinghe moved the following resolution:

> That in the opinion of this Board it is desirable that appreciably large tracts of land should be cultivated with paddy by the Department of Agriculture, under varying conditions of climate, water supply, and health condition, so as to demonstrate the practicability of making the cultivation of paddy a remunerative industry.

He said that, instead of trying to improve paddy growing by mere instruction, the Department should, by taking up land and cultivating it, demonstrate the soundness of scientific theories.

The Hon. Mr. D. S. Senanayake seconded the resolution and added that the best way to get into touch with the goiya was by the creation of demonstration plots as suggested.

His Excellency expressed sympathy with the principle of the resolution and said that the Director of Agriculture had already expressed the opinion that demonstration should be given on the goiya's land and this was in agreement with the principles of the motion. He did not approve of the phrase "appreciably large tracts," as Government was not organised to conduct agricultural operations on a large commercial scale.

The Colonial Secretary suggested that the phrase "appreciably large tracts of land" be amended to read "tracts of land of suitable size."

This amendment was accepted by the mover and seconder, and the motion so amended was carried.

AGENDA ITEM No. 6.—MEANS OF PROMOTING PADDY CULTIVATION

On the suggestion of the President, Gate-Mudaliyar G. A. Goonetilleke agreed that the following resolution which stood in his name be not debated but be referred to the proposed Commission as many of its suggestions were already included in the terms of reference of the Board's Resolution on Paddy Cultivation.

That Government should endeavour to promote intensive and extensive paddy cultivation by the following means:

(1) Repairing or restoring all minor irrigation works now in disuse or disrepair; clearing and maintaining in good order all channels, water-courses and elas under the superintendence of an officer of the Agricultural Department in collaboration with the chief headman.

(2) Making it obligatory on owners of paddy fields to cultivate them by levying a rate or tax on uncultivated paddy fields: giving all Crown paddy land free to applicants for cultivation for a specified period; if there are no applicants for Crown lands and the lands are extensive, by cultivating them under the direction of the Agricultural Department.

(3) Buying up all available paddy, setting up rice mills at different centres and selling the rice to local merchants for retail sale at a lower rate than imported rice, fixing the maximum price.

(4) Giving every facility for transport by public conveyance.

(5) Spreading agricultural knowledge by training village lads with landed interests at an agricultural school free of charge, and appointing such trained men as field officers on a small monthly stipend (Rs. 20/- or thereabouts) to function under the direction and control of the Government Agent.

(6) By having in each locality a model field cultivated under the direction of the Agricultural Department and an agricultural officer periodically visiting each field on a specified day to give demonstrations of improved methods of cultivation.

(7) By giving public recognition in the shape of honorary ranks to those who are instrumental in bringing paddy land under cultivavation.

(8) By directing the Agricultural Department to subordinate all non-urgent activities to an intensive campaign for paddy cultivation.

(9) As the Farm School in the Southern Province has not turned out to be the success that was expected, that premises and appliances be used to give the vernacular school boys of the neighbourhood instruction in the cultivation of foodstuffs side by side with their usual school course, thus instilling into them from their childhood the means of developing their agricultural instinct.

In closing the day's proceedings, His Excellency the Governor expressed the hope that something definite and tangible would result from the work of the proposed Commission. He trusted that the deliberations of that day would not prove nugatory, but result in great benefit to the permanent population of the Island. Any help that Government could give would be given gladly within the limits of the resources of the State. Some of the items which the Commission would consider such as tenancy conditions would not need expenditure at all and he trusted the Commision would be able to send in an interim report dealing with that aspect of the problem.

His Excellency thanked the members for their attendance and support.

JOS. I. GNANAMUTTU.
Secretary,
Board of Agriculture.

Peradeniya, October 28, 1930.

TEA RESEARCH INSTITUTE AND LONDON MARKET

. BOARD'S POLICY ON APPLICATIONS FOR EXPERIMENTS

A meeting of the Board of the Tea Research Institute of Ceylon was held in the G.O.H., Colombo, on Wednesday, October 1st, 1930.

Present.—Mr. R. G. Coombe, (Chairman), the Hon. Mr. D. S. Senanayake, Mr. A. G. Baynham, Mr. F. F. Roe, Maj. H. Scoble Nicholson, Messrs. J. D. Finch Noyes, G. R. Whitby, John Horsfall, Jas. Forbes (Jnr.), T. B. Panabokke, R. R. Muras (Acting Assistant Secretary) and by invitation Dr. R. V. Norris (Director, Tea Research Institute).

Letters regretting inability to be present at the meeting were received from the Colonial Treasurer and the Director of Agriculture.

FINANCE

Referring to the accounts to the end of August, the Chairman stated that he had gone carefully into the financial position to the end of the current year. He anticipated that there should be a small balance in hand to carry forward to next year, after paying for all building work now nearing completion. The second instalment of the loan from Government, he stated, had been paid a few days prior to the meeting.

The accounts were approved without further comment.

INCREASE OF TEA CESS

A letter from the Colonial Secretary was read stating that the proposed alteration to the Ordinance had been approved by the Executive Council, and a draft of the Ordinance was now being published in the "Gazette" prior to the matter coming up before the Legislative Council.

ESTIMATES SUB-COMMITTEE

On the motion of the Chairman, the Board appointed the following to constitute a Sub-Committee, to consider the draft estimates for 1931 : the Chairman, the Director, Tea Research Institute, the Superintendent, St. Coombs, Mr. F. F. Roe and Mr. John Horsfall.

MEMBERS OF THE BOARD

The thanks of the Board were recorded to Mr. A. S. Collett for his services during Mr. Finch Noyes' absence.

BUNGALOWS

Architect's Reports Nos. 15 and 16.—The Director reported that two of the senior staff bungalows had been taken over at the end of September, and Dr. Evans was being transferred to St. Coombs that week. It was anticipated that the two remaining bungalows would be completed by the end of November. Progress was now satisfactory, and the work would be finished under the contract time. The contractors had also made good the defects in the Superintendent's bungalow, and during the recent bad weather no further trouble from leaks had been experienced.

ST. COOMBS ESTATE

Lay-out of Grounds.—At the request of the Chairman, the Director informed the Board that he had been able, through the courtesy of the Director of Agriculture, to secure the advice and assistance of Mr. Parsons

in the laying out of the grounds. Mr. Parsons had already paid one visit and arrangements had been made for supplies of hedge cuttings, ornamental shrubs and trees. It was hoped to have the work completed before the Conference in February.

The Chairman expressed the Board's appreciation of the help given in this matter by the Director of Agriculture and Mr. Parsons.

VISITING AGENT'S REPORT

The Chairman explained that the present report had been made by Mr. *Baillie-Hamilton owing to* Mr. *Ferguson's absence on leave.* The report was a satisfactory one and had been considered on the previous day by the Experimental Sub-Committee. The minutes of this meeting were not yet available, but certain of the suggestions made would now be referred to the Board for consideration.

Cart Road and Bridges.—The Chairman said the position in regard to the Mattakelle cart road was not altogether satisfactory. The Board had given an undertaking to maintain the road in good repair and the necessary steps to implicate this undertaking would be carried out as soon as the present abnormal heavy traffic, due to the building operations, was over. The Superintendent had been instructed to prepare estimates for the work.

New Clearings.—The Chairman reported that the Experimental Sub-Committee had supported the Visiting Agents's suggestions that these clearings should be manured.

The Chairman also called attention to Mr. Baillie-Hamilton's suggestion that "Acacia Decurrens" should be planted out in the clearings. Mr. Ferguson was known not to favour the use of this tree, the Experimental Sub-Committee had in consequence recommended as a temporary measure that "Tephrosia vogelli" should be put in pending further discussion of the point after Mr. Ferguson's return. Both Messrs. Forbes and Horsfall said that they had found "Acacia Decurrens" very satisfactory. After some discussion, the Board confirmed the recommendation of the Experimental Sub-Committee.

Manurial Policy.—Referring to the question of manure generally, Major Scoble Nicholson suggested that competitive quotations should be obtained for manures required for the estate, and the Board supported this proposal.

Mr. Roe asked at what time pruning mixture was applied and was informed by the Chairman that this was usually done about the time of pruning. Several members referred to the possible advantage of applying pruning mixtures before pruning. The Director, replying to these questions, said there were at present available no definite data as to the best time to apply pruning mixtures. The question was an important one to which he had already called attention, and the matter would certainly receive the consideration of the Scientific Staff.

Nurseries.—The Chairman called attention to the note in the current number of *The Tea Quarterly* describing the condition found in the nursery beds at St. Coombs, where there had been considerable trouble with unhealthy seedlings. The Director amplifying this note stressed that no evidence of fungus and insect pests had been found, and the trouble seemed chiefly to be due to the moisture conditions in the higher part of the slopes. Applications of manure had not proved helpful but when the rains set in, conditions had much improved. Before this surface watering had been relatively ineffective owing to the nature of the soil which easily caked forming a hard pan.

Considerable quantities of plants would be required for further openings, and the Board discussed the question as to whether further nurseries should be laid down at St. Coombs, or efforts made to secure stumps from elsewhere. In this connexion it was pointed out that there were many advantages in establishing nurseries in St. Coombs, particularly as this would facilitate the selection of suitable material for the experimental areas.

The Board decided that nurseries should be established at St. Coombs, and asked the Visiting Agent and Superintendent to select a suitable site for these.

TEAS FOR THE LONDON MARKET

The Chairman stated the proposal that the Institute's teas should be sold in London for a year had originated in a resolution proposed by Mr. P. G. Edwards, at a meeting of the Uva Planters' Association, and had been passed on to the Parent Association. He had referred the proposal to both the Visiting Agent and Superintendent, who were both of the opinion that the present crop was too small to receive the same attention on the London market that it did on the local one—an opinion which, he personally and the other planting members of the Board were in agreement with.

When the matter was discussed by the Planters' Association at its last Committee Meeting, he had expressed these views, emphasising at the same time that the Board would, he felt sure, be in sympathy with the proposal and that when the crop from the estate shewed a material increase would be prepared to reconsider the matter.

The Chairman, continuing, reported that a few days prior to the meeting a letter had been received from Messrs. Geo. Steuart and Co. in the same connexion, which the Secretary would now read:

Geo. Steuart & Co.,
Colombo, September 16th, 1930.

The Secretary, Tea Research Institute, Nuwara Eliya.

Dear Sir,—With reference to the suggestion recently put forward by Major Edwards at a meeting of the Uva Planters' Association, to the effect that teas suitable for the London market, as well as for the Colombo market, should be made at St. Coombs, we are instructed by the London Secretaries of the Standard Tea Company of Ceylon, Ltd., for which we act as local agents, to give full support to this proposal.

The Standard Tea Company of Ceylon, Ltd., as a large London Company and a subscriber to the Tea Research Scheme rather feels, we gather, that the present tendency is to study local rather than London interests and perhaps you would be so good as to let us have your views on the subject.—We are, Dear Sir, Yours, faithfully, Geo. Steuart & Co.

The Board supported the Chairman's view that it was not in the interests of the Institute to give effect to the suggestion made in the Uva Planters' Association's resolution for the present.

It was further decided that half chests of the three principal grades should be sent to the Ceylon Association in London, with the request that reports should be obtained from the leading brokers and buyers, connected with the London market.

The Chairman further reported that he had been informed that about half of the present crop sold on the local market was exported to London, the major part of the balance being bought for export to Australia and America.

SEWAGE DISPOSAL ESTIMATES

The Board confirmed the Chairman's action in sanctioning the revised estimates drawn up on the advice of the Sanitary Engineer.

ELECTRIC LIGHT AND POWER CABLES

The Chairman requested the Board's sanction for the expenditure for electric light and power cables at St. Coombs, viz: (1) Power House to Laboratory; (2) Continuation from Laboratory to senior staff bungalows; (3) Power house to present junior staff bungalows; and (4) Extension of No. (3) to additional junior staff bungalow site.

The Board sanctioned the expenditure.

FACTORY EXPERIMENTS

The Chairman said that several applications had now been received from firms and private individuals for the test of plant or systems of manufacture at St. Coombs Factory, and it was necessary for the Board to define its policy in dealing with such applications. The matter had been very fully discussed by the Experimental Sub-Committee which had decided to recommend to the Board the following procedure:

(1) On receipt of such applications, the firm or individual concerned shall be requested to give facilities to the Institute staff to visit a factory in which such plant or process is being worked and to take such observations as may seem necessary in order to assess the scope and value of the process. Such preliminary data will, of course, be confidential and not for publication.

(2) The Institute staff will then report to the Experimental Sub-Committee who will consider the application in detail and make a recommendation to the Board as to whether the proposals should be entertained or not.

(3) The capital cost of installing any such plant should be met by the firm or individual desiring the test to be carried out, and, in the event of the tests being unfavourable, the firm or individual may be required to remove the plant, and, if necessary, restore the original conditions.

(4) In regard to all such work, the Institute will retain full liberty to publish in *The Tea Quarterly* or Institute Bulletins all data obtained whether favourable or otherwise.

(5) In installing any such experimental plant it would seem desirable to obtain a certificate from the firm or individual concerned that the installation as carried out meets their requirements in providing proper facilities for an adequate trial.

After full discussion the Board approved the recommendation of the Experimental Sub-Committee.

Experimental Machinery.—Reported that the two experimental rollers had now been shipped and were shortly expected in Ceylon.

One bank of tats had been constructed and work on the roll breaker and drier was well advanced. It was expected the experimental machinery would be installed about the end of the month.

LABORATORIES

Reported that notice had been given terminating the leases of "Lindfield" and Mahagalla bungalows from December 31st, 1930.

The Director reported that work on the Laboratory had been delayed by the non-arrival of the acid-proof piping. It was anticipated that the building would be completed about the middle of December.

STAFF

Senior Scientific Staff.—The annual increments due to Dr. Norris, Mr. Eden and Dr. Evans were approved.

Renewal of Dr. Evans' Agreement.—Reported that Dr. Evans was proceeding on leave early next year, and that his present agreement terminated on September 5th, 1931.

Resolved unanimously to renew Dr. Evans' agreement on the present terms for a further period of five years from September 6th, 1931. Decided that in the new agreement, Dr. Evans' official designation should be that of "Biochemist."

Junior Staff Provident Fund.—Reported that a simplified scheme for this fund was now under consideration and a further report would be submitted before the next meeting.

New Appointments.—Reported that Mr. D. G. de Zilva had been appointed as 2nd clerk as from September 18th.

EMPIRE MARKETING BOARD

The following letter from the Director of Agriculture was read:

No. A2397, Department of Agriculture,
Peradeniya, 17/21 July, 1930.

(Grant to the T. R. I. from the Empire Marketing Board.)

Sir,—Adverting to correspondence ending with my letter No. A2115 of May 14th, 1929, I have the honour to forward herewith a copy of a letter received from Government on the subject of grant to the Tea Research Institute from the Empire Marketing Board.—I am, Sir, Your obedient servant, (Sgd.) W. Youngman, Director of Agriculture.

The Director, Tea Research Institute of Ceylon,
Nuwara Eliya.

No. A. 2/30, Colonial Secretary's Office,
Colombo, July 15th, 1930.

(Grant to the T. R. I. from the Empire Marketing Board.)

Sir,—With reference to your report No. A2395 of the 4th February, 1930, on the above subject, I am directed to forward herewith for your information a copy of despatch No. 303 of the 13th June, 1930, and its enclosures received from the Secretary of State for the Colonies, and to request you to inform the Tea Research Institute of the sanction by the Empire Marketing Board of a capital grant not exceeding £1,000 to the Institute for the purchase of machinery and plant for the factory, payment to be claimed through this Government on detailed vouchers shewing the machinery, etc., purchased.

2. As regards the Institute's application for grant of £2,000 a year for three years for an invtstigation of the biological control of insect pests of tea and other crops you may inform them that the matter is still under consideration.—I am, Sir, Your obedient servant, (Sgd.) J. C. Jansz, for Colonial Secretary.

The Director of Agriculture,
Peradeniya.

Reported that no further information had been received in regard to the application for a grant for parasite work.

TEA RESEARCH CONFERENCE

On the suggestion of the Chairman, the following Sub-Committee was appointed to make arrangements for the T. R.I. Conference:

The Director, the Chairman, Mr. Forbes (Jnr.), and Mr. Huntley Wilkinson.

Attention was called by Mr. Baynham to the fact that the Census had now been fixed for February 26th and 27th, and it might therefore be necessary to change the date of the Conference.

CONTRACT FOR JUNIOR STAFF BUNGALOWS

The Board confirmed the action of the Chairman in allotting to Messrs. Hemachandra and Co., the contract for the construction of Nos. 5 and 6 junior staff bungalows.

The meeting terminated with a vote of thanks to the Chair.

DEPARTMENTAL NOTES

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA

FOR THE MONTHS OF NOVEMBER AND DECEMBER, 1930

TEA

A further thinning of the *Albizzias* in plot 150 was undertaken in December as it is not intended to lop these trees in future. The trees were uprooted with a monkey jak.

RUBBER

Brown Bast

In December an examination was made of sixty-one trees which had been treated for brown bast in 1926.

The trees can be divided into three classes according to their present condition :

1. Trees of which the treated area cannot be tapped again on account of uneven renewal, numerous large nodules, large wounds, deep grooves etc : 10 trees or 16% of the number treated.
2. Trees of which the treated surface can be tapped, but with difficulty : 17 trees, or 28% of the number treated.
3. Trees of which the treated area can be tapped again without difficulty : 34 trees, or 56% of the number treated.

In none of the above trees has the treated surface yet been tapped again and it is therefore not possible to give an opinion on the principal criterion of success, *i.e.*, whether the disease re-appears on the principal criterion is tapped. In some cases there are indications that the disease is still present in the renewed bark. It is thought that in some instances the excessively uneven surface that has resulted from treatment might have been avoided to some extent by taking greater care not to scrape down to the wood, and by the subsequent regular removal of nodules while they were still small. These points are now receiving greater attention. It is also probable that in some of the trees which now exhibit an untappable surface the disease was present in a fairly advanced state before treatment was undertaken. It is clear that early and regular treatment followed by periodic removal of nodules is essential if losses are to be avoided.

The Rejuvenation Experiment

Plot 2 of this experiment is now in its second and last year of tapping. The two cuts were due to be changed over to the other side at the end of the first year. In some cases, however, the cuts had already been changed over as the first cuts had gone dry, and in some cases these second cuts had also gone dry. In the latter contingency tapping has been resumed on the first cuts, and thereafter whichever cuts have latex are tapped.

A point which has not received previous attention in this rejuvenation experiment is the rubber content of the latex from the trees under intensive tapping. The figures for the first year are given below:

Plot and Treatment.	No. of grammes of dry rubber in 100 c.c. of latex.
1. Daily tapping on two half-spiral cuts. Bark consumption 2 inches per month	23·57
2. Daily tapping on two half-spiral cuts. Bark consumption 1 $\frac{2}{3}$ inches per month.	24·44
3. Daily tapping on two half-spiral per month.	27·35
4. Tapping daily on alternate months with 1 $\frac{2}{3}$ in. bark consumption per tapping month.	31·47
cuts. Bark consumption 1 $\frac{1}{12}$ inch.	

It will be seen that the rubber content of latex is in all cases lower than normal and that it is lowest in the plots where the tapping is most severe and bark consumption is largest.

The New Avenue Rubber Manurial Experiment

The second annual application of manures was made in December according to plan.

Tapping of Budded Rubber, Plot 164

In May, 1930 tapping of 90 budded trees at three different heights was started. Thirty trees are tapped at 5 feet from the ground, thirty at 3 feet, and thirty at 1 foot. The trees comprise twelve small clones.

Yields for the first 6 months of tapping are as follows:

Height of tapping	Grammes of dry rubber per tree for 6 months, May 1st to October 31st, 1930.
5 feet	392·5
3 feet	436·4
1 foot	483·0

It will be seen that these figures indicate an increased yield as the cut gets nearer the base, though probably not such a sharp increase as is found in seedling rubber. It has been stated in Malaya that the yield from a cut approaching the point of union of stock and scion is negligible. Experiments in the Dutch East Indies indicate that the optimum tapping height varies with the clone. When longer records are available from these trees the figures will be compared in detail with figures from other countries.

CACAO

The cacao crop matured rather earlier than usual and, as always, absorbed all available labour in November. The crop was a large one but pod disease, as well as helopeltis, was much worse than usual and the proportion of black cacao will be unusually high.

During November visits were paid to the following cacao estates in connection with cacao selection work: Katugastota Estate, Kondesalle Estate, Pallekelly Group, Rajawella Estate, and Maria Estate. Thirty-nine trees have been selected for recording of individual yields on these estates, and pod records are being maintained by the Superintendents from November 1st, 1930. Sixty-nine trees on the Experiment Station were also selected for the same purpose and similar records are being kept from November 1st.

In December all the trees bearing pods in the Economic Collection cacao plots were examined and those trees not bearing pods true to the desired type were cut out. They will be replaced with budded plants of the desired type.

In eight out of the nine plots planted one or more trees were found bearing pods typical of the variety to which the plots are allotted. All vacancies are already planted with seedlings and these will be budded when large enough.

GREEN MANURES AND COVER PLANTS

In the Iriyagama Division a parasitic *Cuscuta* was observed growing on *Calopogonium mucunoides*. The parasite had spread from a piece of waste land.

FRUIT

Two lines of work on grape fruit have been decided upon :

1. A field test of the varieties already imported. This will entail considerable propagation of plants by budding on the same type of stock—probably pumelo, as these stocks are most easily obtainable in quantity.
2. A test of four different stocks for grape fruit viz., pumelo, Seville orange, grape fruit and nattaran lemon. Seed of the latter variety has not yet been obtained but nursery beds of the other three have been laid down.

A spraying experiment was started by the Mycologist on young imported grape fruit plants in December. Fifteen trees are being used and these are divided into three groups as follows :

5 trees sprayed with ½% sulfinette weekly.

5 trees sprayed with 1% sulfinette fortnightly.

5 trees control (unsprayed).

Notes on the incidence of diseases and pests on each tree were made by the Mycologist before starting the experiment.

OIL YIELDING TREES

The recent planting of *Taraktogenos Kurzii* and *Aleurites montana* in the terraced valley has been very successful. No vacancies have occurred among the *Taraktogenos* and only six in the *Aleurites*. The final number of trees growing at the end of the year was as follows :

Taraktogenos Kurzii in block A,	...	132
,, ,, in block C,	...	133
	Total	265
Aleurites montana in block B,	...	30

Sixty-one seeds of *Aleurites montana* from the only tree in bearing on the station were sown in bamboo pots on November 3rd and these seeds began to germinate about six weeks later. The seedlings will be used for planting in further holes prepared in block B of the terraced valley.

THE ANNUAL ECONOMIC AREA

It was decided in November to discontinue the nitrification experiment which has been in progress for three years in the five quarter-acre plots of this area. Consequently the sugar cane and *Tephrosia candida* used for this experiment were uprooted in December. It is proposed next year to grow an acre of sorghum for cattle food in part of the area which will be rendered vacant.

TUBERS

Six varieties of cassava which are being maintained for stock purposes were dug in plots 19 B and C after replanting cuttings in plot 18 D.

THE IRIYAGAMA DIVISION

Favourable planting weather continued during November and budded stumps were planted out continuously in areas 2 and 7 as the buds sprouted. At the end of that month there were only a few plants still to go out in area 2 and a rather larger number in area 7, for which the budding was done later. The continuance of good planting weather was considered doubtful and it was decided to complete the planting in both areas whether the buds had sprouted or not. This decision proved extremely fortunate as December was exceedingly dry and no planting would have been possible.

A consignment of 103 budded stumps of AVROS 256 was received in November and these were planted in good weather. Sixty plants were planted in the plots allotted to this clone in area 7, while the remaining forty-three were planted in the nursery for budwood multiplication. The stumps arrived in excellent condition.

All the young budded plants in areas 2 and 7 were manured with sulphate of ammonia at the rate of ½ lb. per plant.

Over the greater part of the land not yet included in any area the young rubber trees were uprooted in November. Although it might have been possible to bud these trees next year there are a fair number of vacancies and it was thought that the difference in size of stocks used to fill these vacancies and the larger original trees would be so great as to vitiate comparison.

In area 3 it was observed that the buds of some clones appeared to shoot much more rapidly than others and it was decided to test this point by counting the number of buds of the original budding which had shot exactly five months after budding. At the end of December only six clones had passed the five-month period. The results in these clones were as follows:

Clone	Percentage of buds of the original budding which had sprouted five months after budding.
H 2	64·6
H 401	31·3
H 439	83·0
U. D. 24	58·0
M 162	50·0
H C 34	75·0

The size of all the stocks was much the same and as there was little difference between the actual five-month periods in each case the differences cannot be ascribed to weather conditions. The condition of the budwood doubtless varied, but this would be more likely to affect the percentage of successes obtained than the rate of sprouting of successfully budded plants. The indication is that quick sprouting is a clonal characteristic.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Reco-veries	Deaths	Bal-ance Ill	No. Shot
Western	Rinderpest	47	47	3	29	12	3
	Foot-and-mouth disease	20	20	...	...	20	...
	Anthrax	...	...	...	...	...	...
	Rabies	1	1 *	...	...	...	...
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	..	...	...	...	...	...
	Foot-and-mouth disease	56	56	24	...	32	...
	Anthrax	1	1 †	...	1	...	...
	Rabies	...	..	...	...	...	...
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Cattle Quarantine Station	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	..	...	...	...	...
	Anthrax (Sheep and Goats)	24	24	...	24	...	...
Central	Rinderpest Foot-and-mouth disease Anthrax (Sheep) Piroplasmosis Rabies (Dogs)	FREE					
Southern	Rinderpest	...		...	...	...	...
	Foot-and-mouth disease	143	143	93	...	50	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	..
Northern	Rinderpest Foot-and-mouth disease Anthrax Black Quarter Rabies (Dogs)	FREE					
Eastern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
North-Western	Rinderpest	1115	1115	11	986	12	106
	Foot-and-mouth disease	...	...	...	...	..	...
	Anthrax	...	...	...	..	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	1021	1021	81	875	65	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	..	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	1	1	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	..	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	..	...	...	...	...	...
	Piroplasmosis	1	1	...	...	1	...
	Rabies (Dogs)	1	1	...	...	...	1

* (A cow). † (a cow).

G. V. S. Office,
Colombo, 9th February, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

JANUARY, 1931

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo	87·1	+1·2	72·6	+1·4	71	88	5·6	4·25	11	+ 0·35
Puttalam	84·8	+0·3	70·0	+0·7	74	95	6·2	4·44	11	+ 1·66
Mannar	84·1	+1·1	74·3	+0·7	74	86	5·6	4·15	12	+ 1·34
Jaffna	82·1	+0·4	70·9	−1·1	77	93	5·4	7·47	12	+ 4·59
Trincomalee	80·5	−0·3	74·7	+0·4	79	86	7·1	20·67	14	+14·02
Batticaloa	80·9	−0·3	73·5	+0·6	81	90	7·9	16·99	19	+ 6·74
Hambantota	84·9	+0·2	72·3	+0·3	76	90	5·0	6·67	11	+ 3·28
Galle	83·2	−0·1	73·3	+0·6	80	95	6·2	9·10	15	+ 4·95
Ratnapura	88·3	+1·4	72·5	+0·8	74	95	6·4	9·09	17	+ 3·54
A'pura	82·4	−1·8	68·4	−0·4	78	92	6·4	8·32	9	+ 4·37
Kurunegala	86·3	+0·5	71·1	+1·6	72	90	6·8	6·00	11	+ 2·19
Kandy	81·7	+0·4	67·9	+1·4	70	87	6·1	7·86	15	+ 2·52
Badulla	75·6	−0·7	64·6	+1·3	72	96	7·4	12·50	19	+ 2·95
Diyatalawa	71·6	+0·4	58·3	+1·2	84	97	7·3	9·41	18	+ 3·46
Hakgala	66·5	−0·6	52·5	+1·7	88	91	5·6	19·30	21	+ 9·29
N'Eliya	68·1	+1·8	48·4	+1·9	75	93	6·0	9·58	16	+ 3·81

The rainfall of January was on the whole above average, though small deficits were frequent on the western side.

The excess in the total for the month was well marked throughout the N.P., E.P., and S.P., in the northern half of Uva and the eastern half of the C.P. In the N.C.P. it was consistent, but not of great amount. Small deficits predominated in the W.P. and Sab., in the southern parts of the N.W.P. and Uva, and in parts of the C.P.

The highest totals were 44·05 inches at St. Martin's (Upper), 43·17 at Hendon and 41·56 at Ledgerwatte. The lowest was 1·87 at Berna (N.W.P.).

The heaviest rain occurred during the middle of the month, notably from the 12th to 18th, when falls of over 5 inches in a day were far too common to mention individually. Falls of over 8 inches in a day were recorded at Kiran and Kirimutty (on the east coast, north of Batticaloa) on the 14th, and falls of over 7 inches at St. Martin's (Rangalla) and Tirrukovil. From the 23rd onwards very little rain was recorded anywhere.

Temperatures were on the whole above average, though there was a general fall in night temperatures at the end of the month, and the Nuwara Eliya minimum in air got down to 31·5° on the 31st.

The average wind movement for the month was slightly above average at all stations, though there was little to report in the way of gusts of exceptional violence. Humidity did not differ greatly from average, but the amount of cloudiness was consistently above average and the duration of bright sunshine as consistently below.

A. J. BAMFORD,
Superintendent, Observatory.

The Tropical Agriculturist

March 1931

EDITORIAL

QUININE

THE present year marks the tercentenary of the introduction of the use of quinine from the New World to the Old.

The medicinal properties of the bark of the Cinchona plant were known to the inhabitants of South America long before they were learnt from them by the Jesuit Missionaries. The bark of the plants became known to Europeans as Jesuits' bark because it was through the Jesuit priests that it was obtained by those adventurous spirits who visited the fields of Spanish Conquest in South America. It was through such channels that Jesuits' or Peruvian bark first found its way to Europe in 1630. So common was malaria in Europe at this time that the regular method of purchase of the prophylactic was by putting gold in one scale pan and its weight of bark in the other. The Cinchona shrub was introduced to the East at a much later date after its therapeutic value had become established in Europe. It was Sir Clements Markham who in 1861 first sent seeds of the Cinchona plant to Ceylon and in the following year a consignment of plants was sent to the East through Kew and were distributed to Hakgala and India.

Ten years after its introduction the plant had established itself as a crop of considerable importance in the upland regions of Ceylon. From this time forward Cinchona in Ceylon presented that succession of phases that has marked others of our crops—demand at high prices, disease, neglect and disappearance. At this stage the Dutch came forward with the intensive application of scientific methods and State control. They trebled the yield of quinine from the bark, largely by the application of methods of multiplication by grafting from high-yielding shrubs, until to-day the world's chief supplies of quinine come from Java. The once famous Cinchona forests of South America have now lost their importance. India however under State control produces a considerable quantity of Cinchona bark for her own consumption. From this quinine and other products are produced to the value of some five and a half lakhs annually. These products are made readily available to the people as a malaria specific, being cheaply distributed through the post office and purchasable at a low price wherever one can obtain a postage stamp. Science, however, today has advanced the production of quinine to a stage when synthetic products are upon the markets and the article from natural sources may before long share the fate of indigo.

For the present however if the State, as in Bengal, can provide from natural sources at a cheap rate a supply of quinine for its malaria-stricken population it is its duty to do so. In this issue will be found on another page the report of this industry in Bengal.

ALTERNATIVE GREEN MANURE PLANTS

T. H. HOLLAND, DIP. AGRIC. (WYE),
MANAGER, EXPERIMENT STATION, PERADENIYA

NEW leguminous plants are frequently tried on the Experiment Station, Peradeniya, and though their growth and behaviour may be satisfactory they may appear to have no special claim to be considered superior to the better known plants in general use for the purposes for which the new plants appear suitable. The word "new" in this connection must be taken to include plants not widely used as green manure or cover plants in Ceylon.

Every now and then, however, an estate superintendent reports that he sets a high value on a plant which possibly has not appeared at Peradeniya to have any special merit and has not attracted any widespread interest. It may be in some cases that the plant in question is especially suitable for the particular conditions found on that estate, or it may be that the superintendent has taken a personal fancy to the plant ! In any case it is always a good thing to have a second string to one's bow and to know that there are serviceable alternatives to the plants commonly used. The following plants appear to have some promise, and seed is available in limited quantities from the *Experiment Station, Peradeniya, or from the Central Seed Store*, Peradeniya. It may be mentioned that the uses of all these plants are fully discussed in Section II of the Manual of Green Manuring which is awaiting publication. Multiplication of seed of most of these plants would be an easy matter should a demand arise.

TREES

Cassia didymobotrya.—This small leguminous tree has given satisfaction at least to two estates in Dimbula. It is easily propagated from seed, and furnishes a good weight of loppings which are rich in mineral constituents. At Peradeniya growth is more rapid and apt to be straggly. In any case young plants should be staked.

Derris microphylla.—This is now a very popular shade tree for tea and coffee in Java. It is suitable only for mid and low-country. It is reported to grow rapidly, stand wind well, and to be immune to a considerable extent from pests and diseases. The tree is reported to be giving satisfaction on Sirikandura Estate, Matugama. Seed was recently imported by the Central Seed Store, Peradeniya.

Dalbergia assamica.—This tree which gives a light shade and considerably resembles *Albizzia moluccana* has made very rapid and healthy growth at Peradeniya.

BUSH PLANTS

Crotalaria brownei.—It is not claimed that this plant is superior to *Crotalaria anagyroides* or *C. usaramoensis*, but recent trials show vigorous growth and the possibility of a useful supply of green material in the young stages. A limited quantity of seed is available.

Desmodium cephalotes.—This indigenous plant has a spreading habit and may prove useful for lopping. The first plants grown produced an abundance of seed and some of this will be used for multiplication in the next rains.

Desmodium gyroides.—This erect plant has been grown for some years on the station but has not yet attracted much attention. It provides, however, a good weight of green material and stands lopping at least better than the *Crotalarias.*

Indigofera suffruticosa.—This plant very much resembles *Indigofera arrecta* which is fairly well known. It can be easily distinguished from that plant by its seed pods which are curved instead of straight. Its habit is perhaps slightly more spreading than *I. arrecta.*

Tephrosia tinctoria.—This plant is very easily grown at Peradeniya and gives a satisfactory light even cover. The weight of green material afforded is less than that available from *T. candida* or *T. vogelii.*

Tephrosia vogelii.—This plant has achieved some popularity in a few districts but has possibly not yet received as much attention as it deserves. It has some resemblance to *T. candida* (Boga medelloa) but can be very easily distinguished by its seed pods which are much larger, very hairy, and have a texture resembling that of a veloor hat. At Peradeniya it is indicated that the production of green material is more prolific in the young stages but the life of the plant is shorter than that of *T. candida.* The great point in its favour is that the seed pods are much less liable to insect attack than those of *T. candida.*

CREEPERS

Dunbaria heynei.—This indigenous creeper forms a very satisfactory cover where it is found to be growing spontaneously. It has been found most satisfactory in young rubber on the Kegalle Experiment Station.

Pueraria phaseoloides.—This creeper is perhaps better known under the name of *Pueraria javanica.* It forms a heavy cover at Peradeniya and seeds prolifically.

THE CINCHONA INDUSTRY IN BENGAL*

1. *General.*—Although the interests of public health, in so far as these are dependent on quinine supplies and their distribution, cannot be shown to have been advanced far during the year, and although the correlation of suppply and demand in this market presents its old-time difficulties, the year has been a favourable one indeed for the Cinchona Department. A season exceptionally well suited to the growth of established Cinchona with a bumper bark harvest and steady progress in the factory is reflected in accounts which are at once a vindication of past policy and a pointer to what may be expected from its continuance in the fields of Cinchona and Quinine production.

But we have been working under favoured conditions, and to the year's success sound plantation management and fortunate climatic conditions have not alone contributed.

Quinine holds a position unique in a world of surplus commodities. For a series of years the price of the drug has remained unaffected by all those factors which have been operating in other fields. In 1926 Rs. 18 was fixed by the Kina Bureau as the price at which its product should be released, and the power of those who guide supply in this commodity may be gauged from the fact that fluctuations in price have reflected little more than differences in exchange values during the intervening period. When it is realised that overproduction in quinine is as marked as it is where some of the world's staple commodities are concerned the question may well be asked how quinine escapes effects so evident elsewhere. The answer is that while it is being produced in quantity in excess of the world's demand stocks are still well below real world requirements as measured by health standards, and both price and production remain under a control which, called for and welcomed by the industry itself is now loyally supported as in its best interest and as the only means of maintaining its steady economic development.

We are here, therefore, dealing with production under control. In cases of overproduction the absence of control does not require in these times to have its effects demonstrated. We see them in the rates for tea, rubber and tin, to mention three important eastern products only, falling to a point that makes the less well-managed concerns go to the wall. Prices, indeed, in some cases have reached a point beyond which the industries continue only in the hope of better times and because of the disorganization and difficulty of reorganization that would follow a disruption of labour forces.

That it is otherwise in the Cinchona and Quinine industries has been to the benefit of all concerned in these different trade times, and if the Cinchona Department can with others regret the restricted use of its product it can yet rejoice in the guidance the industry has and congratulate itself in escaping the depression so evident elsewhere. For here both price and production are steady, the former because, in spite of much that is said to the contrary, it is not greatly in excess of costs, the latter because the product remains unaffected by long storage and the industry can afford to await a time when effective yearly demand will more nearly balance, if not exceed, yearly harvests.

* From the Sixty-Eighth Annual Report of the Government Cinchona Plantations and Factory in Bengal for the year 1929-30.

The reasons for such strength in this industry are interesting. Political causes have determined that in the areas of South America where the plants are native, labour cannot be organised to develop and maintain a Cinchona industry thriving as it would thrive nowhere else, and outside its native limits the plant takes unkindly to generally prevailing climatic and soil conditions. They are chance coincidences that the one area of the world outside America most suitable for this cultivation should be limited to two large islands in the Malayan Archipelago, that both these islands should be governed by a single Power and that this Power should be that which, above all other European, has shown powers of co-operation in production and marketing and an ability equal to the best in matters of the scientific organization and development of land industries. With these considerations for backing the result does not surprise and we find an industry standing up against world economic disruption as no other industry is standing.

The steadiness of price might indicate monopolistic influence; indeed it is to this that it is usually ascribed, and yet the only monopoly the Dutch have has been determined for them by the fact that quinine, the Cinchona alkaloid easiest of production in their possessions, is also the one most favoured as a febrifuge by the medical world. Were it otherwise the history of the campaign against malaria might read very different to what it does. The favour that quinine enjoys above others may rest on well found clinical experience but it is not the only alkaloid nor is it the only useful one, and, strict adherence to it has directed the effort against malaria in a way that is, perhaps, too little understood. Quinine is, and, till South America is more settled politically, must always remain a Dutch Eastern product. No other known part of the world can compete with Java. Its climatic and soil conditions give it advantages unknown elsewhere so far as the particular alkaloid quinine is concerned. But the preference shown for quinine has determined more than has anything else the limitation of areas suitable for development as febrifuge yielding centres, and it more than any other is the real cause of such monoply as the Dutch now exercise in this field of production. It is a monoply that nature forces on Java by reason of medical preference. The rigid adherence to quinine connotes the maintenance of a monopoly in the true sense of this word. It means the continued development of a Cinchona industry directed towards quinine when an industry having as its aim a balânced production in greater mass of all the useful alkaloids might have more far-reaching effects in the world control of malaria. We cannot get away from the fact that quinine is the rich man's remedy while malaria is the poor man's heritage, but let medicine once admit and practise the value of the other alkaloids and many Indian areas might then be turning out febrifuges at costs more suited to the poor. For with a change in medical opinion and practice we could make use of kinds of Cinchona that do not demand Java soil and climatic conditions for their best development, and the truth will have been recognised that the elimination of malaria means first its control in that section of the population which has scarcely heard of quinine and which cannot afford to buy it even at cost price. If the year's accounts show that the problems of production are being tackled with success this is the better reason why the present difficult problems of consumption should not be brushed aside. They are great but on their solution depends further advance, and so long as they are not solved must the success attained in production miss its mark.

2. *Extensions, Acreages and Crops.* (a) *Mungpoo*—Rainfall for the year was considerably above the average and varied between **135** inches on Labdah to **187** on Sittong. Mungpoo division with **142·5** inches compares with previous recorded yields. Rain fell in each month of the year and this

taken with normal temperatures accounts for the flourishing condition of Cinchona on this plantation. The writer has never seen the lower blocks so free of insect disease and taking the blocks all over, has never seen Cinchona on this plantation look so well as it did towards the end of the year. Favourable appearances are also accompanied by better laboratory records for the barks, and it is interesting to note that analyses of Ledger barks now average over 5 per cent.

To obtain reliable samples for analytical purposes small quantities per maund are saved from each barking operation, thus obviating the objection to averages obtained from a limited number of selected trees. Hybrid blocks are also averaging well with Hybrid II on the different divisions showing percentages of 5·06, 4·55, 4·58, and 4·74. The improvement in Hybrid bark may be of first importance not only to Cinchona in the Darjeeling district but to the cultivation of this tree in many areas not yet tried. For the Hybrid tree is more robust than either of its parents and thrives at elevations and in soil conditions not suited to them. It is particularly gratifying to find last year's planting at low elevations looking so well, for at one time everything in these blocks pointed to failure and had there been a heavy eventual mortality it would have occasioned no surprise. As things are, the mortality is negligible and, given any luck in the current yearly conditions, a real good area of well-established Cinchona at an elevation lower than where one looks for the best should result.

But nowhere is the success of the year more apparent than in coppiced blocks. The operation of coppicing with a finely balanced tree like Cinchona is always attended with some risk and it is, therefore, gratifying in a way that success in other operations is not to find a coppiced area breaking regularly and freely and to see it springing up in a fresh crop of Cinchona without any of the risks attending nursery work and inclement planting weather.

An extension of 130 acres for which 205,870 young plants were reared enabled the plantation to balance the acreage cut out and retain a fully stocked area of 1,049 acres. The new blocks were made up of 59 acres Ledger on Mungpoo and 22 acres Ledger on Labdah, 17 acres Succirubra on Mungpoo and 32 acres Hybrid II on Labdah. Excellent weather conditions prevailed at the time of planting and the land selected was in good fettle after a twenty years' rest in young forest. These blocks are confidently expected to do well.

Harvests were obtained by cutting out 116 acres Ledger, 4·2 acres Succirubra and 9·8 acres Hybrid II. The yields were 415,916 lb. Ledger, 16,420 lb. Succirubra and 35,441 lb. Hybrid barks, total 467,777 lb. the largest harvest ever got from this plantation. The harvest came from the coppicing of three eigth-year-old blocks, from casualties throughout the plantation and, to a lesser degree, from the pruning of young overcrowded Cinchona. The average ages of the Ledger, Succirubra and Hybrid barks were 9·2, 10·9 and 8·7 years, the average annual increments calculated on the harvests 387, 358, and 412 lb. The average age of all barks cut is 9·2 years and the average annual increment 390 lb.

(b) *Munsong*—Rainfall for the year was 109·56 inches which is 12·28 inches above normal. The total represents a plentiful supply for Cinchona and generally the distribution was good. There were, however, excessive falls in September and October that did more immediate damage by washing out plants and destroying roads than ultimate good in keeping the soil moist for the first period of the oncoming dry weather. Nurseries suffered considerably from cold which accompanied the rain in January and February, but apart from this the year was exceptional in that no material damage resulted from drought.

Variations in temperature from day to day were more marked than usual. The lowest recorded at 4,250 feet was 40° and this occurred several times from December to February. Damage by hail, the most destructive element next to prolonged drought and usually prevalent in times of low temperature has, however, not been reported.

In spite of the prevalent nursery disease the extensions of last year have done quite well as is evidenced by a vacancy percentage of 10·3 in Kashyem Ledger 29. This, however, is the block giving best results and something between its percentage and a failure of 33 per cent. on Munsong Ledger for the same year can be taken as representative of the year's success. Experiments with shade trees and green manures are helping to prove where further planting can be tried on land that has already borne one Cinchona crop. The majority of the blocks were given a deep forking during the year with the help of outside contract labour. A stage has now been reached in this plantation when further extensions must go on land that has already borne its crop, but everywhere the presence of scattered Cinchona will prevent homogeneous planting. These conditions are the direct result of a policy of bark importation with its corollary of late and gradual local harvesting and of the retention of healthy plants wherever possible and regeneration by wholesale coppicing. For some considerable time no area has been completely uprooted, and, as no new good land remains, extensions henceforth must take the form of repeats in areas still partially stocked. The policy of coppicing any plant that had the slightest chance of growing has been called in question during the year by large numbers of stocks failing to break, but admitting that this makes the final removal of bark more difficult, the practice must continue so long as the nursery disease interferes with our normal planting programme. In its presence nothing will justify the complete removal of Cinchona that, coppiced, might again yield its bark harvest.

The continued prevalence of the nursery epidemic overshadows all other plantation considerations for the moment. Further experiments in the disinfection of nursery soils and sites have not pointed to any easy specific for the disease, but it was premature to say that a plant once attacked was doomed in the struggle against it. This is not borne out by subsequent experience and the attempts made by mildly attacked plants to throw off the disease once in the open is perhaps the most promising indication of how the trouble may be countered. Very early planting to permanent situations in the field before the condition becomes epidemic in the nursery, may prove at once the prevention and cure of the disease and the solution to a problem that is of immense importance to Cinchona in the whole district.

The effect of various degrees of nursery shade is being tested and, with the idea that the times of sowing may affect the virulence of the attack, experiments in this direction are being carried out.

The outstanding facts of the year are that the disease persists and that a good measure of success has been attained in spite of it. Its presence on Mungpoo has also been established but here it is not epidemic and does not show up till after the plants have passed the nursery stage.

Extensions, by which is meant the area of young plants put out irrespective of whether they grow on new or old Cinchona land, comprised 56·5 acres Ledger only, 40·5 acres on Kashyem and 16 on Munsong division. This is a meagre extension but the factors conditioning it are well known to Government.

Harvests were obtained by cutting out 141·4 acres Ledger, small areas of just over 2, 2, and 3 acres of Officinalis, Succirubra and Hybrid III and 17·2 acres of Hybrid II. The yields were 567,539 lb. Ledger, 5,477 lb.

Officinalis, 12,845 lb. Succirubra, 8,778 lb. Hybrid III and 67,986 lb. Hybrid II, making a total of 662,625 lb. for the year. The average ages of the Ledger, Officinalis, Succirubra and two Hybrid barks in above order were 10·9, 16·3, 13·2, 9·6, and 12·6 years and their average annual bark increments 368, 146, 317, 292, and 313 lb. respectively. The average age of all cut barks was 11·16 years and the average annual bark increment calculated on the harvests 355 lb.

Labour supplies, due no doubt to the depressed state of the tea industry, are more satisfactory on Munsong than they have been for years. There is a balance of 148 to the credit side in the force which seems more settled since an increased quantity of piece work has been given out.

3. *Factory Work.*—Besides, 28,127 lb. Java and 21,080 lb. Burma bark for the Government of India, 485,298 lb. Mungpoo (450,536 lb. Ledger, 12,818 Succirubra, 21,944 Hybrid) and 575,358 lb. Munsong barks (499,922 lb. Ledger, 7,188 lb. Officinals, 9,691 lb. Succirubra, and 58,557 lb. Hybrid) were worked up to produce 29,050 lb. quinine sulphate powder (crude), 4,919 lb. and 79,297 boxes tablets, containing combined, approximately 13,000 lb. quinine sulphate, 726 lb. other quinine salts, 15,681 lb. Cinchona febrifuge powder and 4,397 lb. Cinchona febrifuge powder converted to tablets.

The Java and Burma barks produced 2,090 lb. quinine sulphate and 932 lb. Cinchona febrifuge powder.

The Mungpoo bark had an average quinine percentage of 4·22 and the Munsong 4·42.

Only 13,940 lb. of the sulphate were fully purified and packed, the remainder being left half purified and stored in the large concrete bins. This expedient is rendered necessary by the large and steadily accumulating stocks and by the failure, so far, of all attempts to finance their use in the malaria campaign. No salts of other Cinchona alkaloids were manufactured during the year but some 100 samples of local bark and 79 samples of Burma bark were analysed with a view to the selection of seed trees. The large areas growing out in Burma added to drains on the seed harvest following nursery disease make the question of supply an important one.

The work on tablets which till a few years ago was done by juvenile jail labour, has been very successfully transferred to machinery at the factory and is running both smoothly and efficiently and at greatly reduced cost. A tendency to order quinine in tablet form is now noticeable and is likely to become more pronounced. Steps have been taken to substitute glass tubes for the cardboard cases now used and machining has arrived from home for the manufacture of the necessary caps. The appearance of the make-up will be enhanced and in this respect the Government product will be brought into line with the more attractive trade brands of quinine.

4. *Cost and Value of Plantation Bark.*—The figures 3·6 annas for Mungpoo and 2·7 annas for Munsong bark are retained. Mungpoo total harvest of 467,777 lb. and Munsong 662,625 lb. therefore, cost Rs. 105,249 and Rs. 111,818, total Rs. 217,067. The unit rate for bark taken at 1 anna gives the Mungpoo bark harvest with an average quinine percentage of 4·9 for Ledger, 3·08 for Succirubra, and 4·73 for Hybrid a value of Rs. 141,011 or Rs. 35,762 more than its cost. The same unit rate for Munsong barks with percentages of 4·62 for Ledger, 3·58 for Officinalis, 2·55 for Succirubra and 4·07 for Hybrid gives the harvest from this plantation a value of Rs. 186,674 or Rs. 74,856 more than its cost.

The pond unit rate is retained at one anna for valuation purposes, a figure low enough to serve for both standing and harvested bark.

5. *Cost and Value of Quinine Produced.*—(a) Cost in the bark. Not counting a questionable amount of quinine passing through into the febrifuge, 29,050 lb. crude quinine sulphate, about 13,000 lb. sulphate in tablets and about 726 lb. in other salts, a total of 42,776 lb. were contained in 1,062,806 lb. mixed Munsong and Mungpoo barks, costing at 3·6 and 2·7 annas a total of Rs. 206,768. The cost per lb. of quinine in the bark was, therefore, Rs. 4·83.

(b) Cost of extraction, packing and delivery to railway.—No advance on the figure of Rs. 2·721 for cost of extraction has been made. It has been used as a basis for charges to India and it is not proposed to change it pending the elaboration of commercial accounts.

(c) Total cost per lb. and value.—This is made up of the cost in the bark Rs. 4·83 and cost of extraction Rs. 2·721, a total of Rs. 7·55.

The wholesale rate being Rs. 18 per lb. the 42,776 lb. quinine extracted in all forms as above defined are worth Rs. 769,968 but cost only Rs. 322,958.

6. *Sales and Selling Rates.*—No change has taken place in the selling rates since last report was written, there having been only fractional changes in the open market quotations.

Sales reveal in comparison with last year the following main differences —quinine salts exclusive of tablets 8,431 lb. sold against 11,502 lb. last year; Cinchona febrifuge 16,087 lb. against 17,633 lb.; quinine sulphate tablets by weight 4,147 lb. against 3,470 lb.; by treatments 89,718 boxes against 79,612 boxes. The total sales of all kinds cash and credit and including Rs. 5,190 received direct by the Department for miscellaneous products amounted to Rs. 617,513. Of this Rs. 285,481 were by sales of quinine tablets.

7. *Expenditure and Receipts.*—The total expenditure of the department (including pensionary charges) was Rs. 416,096. Total receipts exclusive of Rs. 5,717 from land rent, grazing fees, etc., paid to the treasury not to the credit of the Cinchona Department, but inclusive of Rs. 5,190 received direct from miscellaneous products, etc., were Rs. 617,513. Of this amount a sum of Rs. 29,648 is deducted for credit to the Jails Department for distribution of products, leaving a balance of Rs. 587,865-8 for entry in the profit and loss valuation account.

Outstandings at the end of the year amounted to Rs. 18,612-8 being Rs. 11,229-8 unrealised sales, Rs. 5,687 for extraction of 2,090 lb. sulphate at Rs. 2·721 per lb. and Rs. 1,696 for extraction of 932 lb. febrifuge at Re. 1·82 per lb. on behalf of the Government of India.

THE WORLD'S RUBBER SUPPLIES*

IN the course of a paper on "The World's Rubber Supplies," delivered at *Birmingham before the Midland Section of the Institution of* the Rubber Industry by Dr. George Rae, D.Sc. (Messrs. Harrisons and Crosfield, Limited), on Tuesday, 13th January, 1931, the speaker pointed out that rubber is to-day mainly obtained from plantations, wild rubber, which 30 years ago was the only source, representing only about 3 per cent. of the total world supply. Under the stimulus of the high prices obtaining during the early years of the century rubber planting was carried out at a rapid rate, especially after 1905, both by Europeans and Asiatics. *The Asiatic proportion rose from about 20 per cent. of the* total in 1910 to 35 per cent. in 1920 and to over 50 per cent. in 1930.

The total area under plantation rubber at the end of 1929, continued Dr. Rae, was between 6,600,000 acres and 7,200,000 acres, of which the area under native rubber in the Dutch East Indies variously estimated at between 1,100,000 acres and 1,700,000 acres. The estimates of the area under Dutch native rubber are based on the exports of this rubber and on the opinions about its average yield per acre and about the proportion of its immature to its mature rubber. The remaining 5,500,000 acres consists of approximately 3,360,000 acres in estates owned by Europeans *and Americans; 510,000 acres in Asiatic-owned estates over 100 acres* and 1,630,000 acres in native holdings under 100 acres. About 80 per cent. of all the estate rubber trees are tappable. 90 per cent. of the native rubber in Malaya and Ceylon is tappable and probably less than 50 per cent. of the native rubber elsewhere is tappable. Owing to the drastic *system of tapping pursued by the natives, a portion of their untapped areas* must be regarded in the same light as bark reserves of estate rubber.

The total exports of rubber from producing countries were 94,000 tons in 1910, 167,000 tons in 1915, 353,000 tons in 1920, 518,000 tons in 1925, 861,000 tons in 1929, and will be about 820,000 tons in 1930. Under *normal conditions of production, exports give a good approximation to* output and the stock figures now published will usually indicate any significant divergence between output and export.

The nett exports from the various producing countries during the years 1920, 1925, 1929 and 1930 are given in the following table (the 1930 figures are subject to adjustment when complete data are available):

	1920. Tons.	1925. Tons.	1929. Tons.	1930. Tons.
Malaya	181,000	210,000	455,000	443,000
Ceylon	39,000	46,000	80,000	77,000
Netherlands E. Indies	80,000	189,000	256,000	241,000
India	6,000	10,000	12,000	11,000
British N. Borneo	4,000	5,000	7,000	7,000
Sarawak	2,000	9,000	11,000	10,000
French Indo-China	3,000	6,000	9,000	7,500
Siam, etc.	1,000	4,000	5,000	4,500
Wild	37,000	39,000	26,000	19,000
Total	353,000	518,000	861,000	820,000

* By Dr. Geo Rae, D.Sc. in *The India Rubber Journal* Vol. LXXXI. No. 3, 1931.

The actual *output* of rubber for the year 1929 distributed according to the nationality of producers was approximately as follows:

		Tons.		Per cent.
British: U.K.	...	236,000	...	27·9
British: Local	...	69,000	...	8·1
Dutch	...	57,000	...	6·7
Other European	...	30,000	...	3·5
American	...	22,000	...	2·6
Asiatic Estate	...	64,000	...	7·6
Malayan Native	...	199,000	...	23·4
N.E.I. Native	...	108,000	...	12·8
Other Native	...	36,000	...	4·3
Wild	...	26,000	...	3·1
	Total	847,000		100·0

During the last few years, resting, a better knowledge of the effects of various tapping systems, increased cultivation and conservation of surface soil have increased the yield and probably prolonged the productive life of the estate rubber tree. By far the most important development, however, has been the planting of high-yielding material by means of bud-grafting; the area under budded rubber is unknown, but brobably does not exceed 5 per cent. of the total planted area.

Owing to the low price of rubber many estates are now harvesting a restricted crop; more will restrict during 1931; but a considerable number may find it necessary to harvest a full crop. Dutch native output had declined largely owing to the disappearance of markets in the relatively inaccessible districts and to lack of hired labour at the current prices, but will again increase when the price rises. The output of Malayan native rubber during 1930, for which so far there has always been a market, has been maintained at about the 1929 level, although during the last three months it has shown a tendency to fall off; any falling off will be due to depletion of bark reserves.

The absorption of rubber by manufactures (*i.e.*, the quantities or rubber they turn into rubber goods) was 85,000 tons in 1910, 150,000 tons in 1915, 310,000 tons in 1920, 560,000 tons in 1925, 790,000 tons (adjusted figure) in 1929, and will be approximately 705,000 tons in 1930.

The absorption by manufacturers in the United States is given monthly by the Rubber Manufacturers' Association of America; similar data are not available for other countries, but their absorption can be measured approximately by their nett imports, adjusted in the case of the United Kingdom for variation in the stocks in public warehouses in London and Liverpool.

The absorption of the principal manufacturing countries for the years 1920, 1925, 1929, and 1930 (preliminary figures) are as follows:

	1920. Tons.	1925. Tons.	1929. Tons.	1930. Tons.
United States	215,000	390,000	470,000	380,000
United Kingdom	24,000	30,000	72,000	74,000
France	16,000	34,000	62,000	67,000
Germany	13,000	34,000	49,000	46,000
Italy	6,000	11,000	16,000	15,000
Russia	—	8,000	13,000	17,000
Belgium	3,000	3,000	9,000	11,000
Scandinavia	2,000	3,000	5,000	7,000
Canada	12,000	20,000	36,000	29,000
Japan	6,000	13,000	34,000	32,000
Australia	3,000	5,000	16,000	5,000
Other countries	10,000	9,000	23,000	12,000
Total	**310,000**	**560,000**	**805,000**	**705,000**

For the years 1928 and 1929 a further adjustment (estimated roughly at 15,000 tons) is necessary to allow for the obvious variation in the stock of crude rubber in the hands of manufacturers outside the United States.

The absorption of rubber has shown considerable fluctuation about its trend during the last twenty years which have probably been of greater amplitude than those shown by the real consumption of rubber. Stocks of manufactured goods, including the unused tyre mileage on automobiles, must, therefore, have shown considerably annual fluctuations during the last twenty years—a matter of considerable importance when considering stocks of crude rubber.

The data both for supplies and deliveries of crude rubber are reasonably complete and reliable, but the data giving the world stocks are very incomplete. Such data as exist, however, indicate that under normal conditions of production, stocks of crude rubber in producing countries and quantities afloat represent mainly working stocks and are not likely to show much fluctuation beyond that due to seasonal variations in output. The only important stocks in manufacturing countries are those in public warehouses in London and Liverpool and in the United States. The stocks in the hands of manufacturers in the United States have usually been between 60 and 80 per cent. of the total United States stocks. The stocks in London and Liverpool are the main reservoirs of immediately available rubber and have accordingly shown large fluctuations during the last twenty years.

The total world stocks, declared and undeclared, at any time must be considered in relation to the monthly world absorption at that time and the ratio of the former to the latter has varied from 5½ to 11 during the past two years and has shown even greater fluctuation in the past. A total world stock equivalent to about six months' absorption is usually regarded as necessary for the smooth working of the industry.

INVESTIGATION INTO THE RELATION BETWEEN THE DIAMETER OF THE LATEX TUBES AND THE RUBBER PRODUCTION OF HEVEA BRASILIENSIS*

INTRODUCTION

The theory of Ashplant.—During the last two years H. Ashplant has developed a theory, according to which it would be possible to distinguish with practical certainty high-yielding rubber trees as early as in the nursery stage, so that useful superior planting material could be selected from a very heterogeneous mixture. Ashplant's statements are founded on assumptions, which can be summarized as follows:

1. In a Hevea tree a very striking correlation exists between the yield capacity and the diameter of the latex tubes. This correlation is considerably better than the relation found between the number of latex rings and the yield of rubber.

2. A hevea tree with latex tubes with large diameter in the bark also has large bore tubes in the leafstalk.

3. The size of the diameter of the latex tubes in an individual tree is constant during the whole duration of life, from its earliest youth (6 months old), and hereditary.

From these hypotheses the conclusion is drawn, that a single cut through the leafstalk of a 6-month-old Hevea seedling suffices to decide in all probability whether the tree, when tappable, will be a good or a poor yielder. Unfortunately no proof is adduced for the second and third of the above-mentioned hypotheses, whilst the first is supported by two correlation tables in Ashplant's third publication. In our opinion it is however an omission that not one of the three preliminary papers mentions how the diameter of the latex tubes can be measured with the degree of accuracy given in the correlation tables.

Since this new method of selection would be invaluable for practical purposes, an investigation was started to test this theory after the third publication (December 1928) had not given the detailed description, repeatedly promised, of the method to be used. The more so since on theoretical considerations, mentioned hereafter, a very striking correlation between the diameter of the latex tubes and the production can be expected.

As a consequence of lack of data in his publications it was impossible to adhere to Ashplant's method of working, so that we had to work out our own method of measuring (section 5). It follows that this treatise can only aim at a control of Ashplant's fundamental idea, and unfortunately it is not possible to make a comparison with the figures obtained by him according to an unknown method.

* By Dr. Frey-Wyssling in *Archief voor de Rubber cultuur*, Vol. 14, No. 3, March 1930.

Unfortunately the greater part of the available time was spent in working out a flawless micro-technique for the measuring of the diameter of the latex tubes; consequently the number of trees of which measurements have been recorded is comparatively small; notwithstanding this fact the data are convincing. With a view to the complaints which have been worded of late on the lack of a satisfactory method of measuring, the author considers it desirable to publish his records in order to save investigators from such a loss of time in working out a satisfactory technique.

I. THEORETICAL CONSIDERATIONS

1. *The volume of latex tubes.*—When estimating the value of rubber tree according to the quantity of rubber contained in the stem, by considering the volume (1) of the latex tube system, as done by Bendixen it is at once evident that the diameter of the latex tubes plays a far more important part than all other factors which come under consideration.

Assuming that the latex tubes are straight capillaries, the volume of a cylindrical stem (budding) is :—

$$I = n.a.o.r^2 \pi l \qquad (1)$$

in which n = number of latex rings
a = number of latex tubes per 1 c.m. of ring
o = circumference of the tree in c.m.
r = radius of the latex tubes in c.m.
l = length of the stem in c.m.

This equation shows that the volume is proportional to be the square of the radius of the latex tubes, whilst all other factors such as the number of rings (n) the circumference (o) etc. only occurs in the first power.

The presumption that the tubes are straight capillaries is however incorrect, since they form a network. Therefore the volume is more accurately determined by measuring the *area of 1 sq. cm. of the network* by means of a planimeter. The figure thus obtained is a measure for the denseness of network and can be used in the equation (1) instead of a.r. The volume is still proportional, though indirectly, to the square of the radius of the latex tubes.

It follows that a tree, which has latex tubes with a diameter twice as large as those of another tree with an equal number of rings, the same circumference etc., contains four times the quality of latex found in the tree with smaller tubes. This is evidently in favour of the theory of Ashplant.

But actually a yielder should not be classified according to the volume of its system of latex tubes; for what is the value of a considerable quantity of latex if it does not flow out easily and to a satisfactory extent ? Tapping is a dynamic problem and static considerations are not worth much, if we try to obtain the latex from the bark, although naturally the quantity of latex in the whole system of tubes comes under consideration as a reservoir for the issuing latex.

3. *Dinamics of the latex flow.*—Liquid moving in narrow tubes follow the law of Poisseuille. According to this law the volume V which flows from a tube during the period t is :

$$V = \frac{\pi . p. r^4}{8. l. \eta} . t \qquad (2)$$

in which p = internal pressure in the tube
r = radius of the tube
l = length of the tube
η = internal friction (viscosity) of the liquid
n = internal friction (viscosity) of the liquid
t = period of flow.

For the latex tubes, (p) is the turgor in the system of tubes and (1) stands as a measure for the area drained; *i.e.*, the area in which the latex flows in the tubes with a given velocity. The observations of De Vries give an idea of the internal friction (viscosity) of the latex; for the equation of Poisseuille however the absolute value is required and not the relative value.

Taking into consideration the number of latex tubes opened by the tapping cut, the following volume of latex V can be expected:

$$V = \frac{n,' a. o.}{3} \frac{\pi. p. r^4}{l. \eta} . t \qquad (3)$$

where (a) and (o) have the same meaning as in equation (1) (only $\frac{1}{3}$ of (o) comes into consideration), whilst (n') no longer stands for the total number of rings, but for opened "productive" rings (see section 10).

It goes without saying that no absolute value can be given to this relation, since the latex tubes are not straight capillaries and the problem of flow is so complicated on account of the numerous anastomoses which interconnect the tubes, that it hardly admits of a mathematical solution; moreover the magnitudes (p) (1) and (η) change during tapping. However *equation (3) gives an insight into the relation between the quantity of latex* of flowing out and the various factors. It is to be expected, therefore, that the quantity of latex produced during tapping will be proportional to the number of "productive" rings (n') the number of tubes per cm. of ring, the circumference (o) the turgor (p) the period of flow (t) and in inverse proportion to the length (1) through which the latex is pressed. On the other hand the quantity of latex flowing out will increase with the fourth power of the diameter of the tubes! A tree with tubes twice as wide as those of another tree, comparable in all other respects would produce 16 times as much latex than latter. Only if four different factors in equation (3) were doubled simultaneously (1 and η divided by 2) would the yield of the second tree equal that of the first. This being precluded, it follows that the diameter of the latex tubes is theoretically the predominant factor in the latex flow, and therefore the theory of Ashplant seems to be remarkably well founded.

2. METHOD OF INVESTIGATION

3. *Suggestions for the investigation.*—Whilst Asplant discusses his theory at great length, the reader is left absolutely in the dark as regards his technique, the data on this being very scanty.

From the discussions of his theory in the literature it is permissible to conclude that he uses a projection apparatus for measuring; it is even mentioned that accurate measuring would be impossible without the use of this apparatus. On the other hand we have the fact, known to every investigator well versed in handling the microscope, that projecting does not increase the accuracy of the microscopic image. If for instance the diameter of a cell can be measured in the microscope with an accuracy of 5%, the projection, enlarging the microscopic image a hundred-fold, does not permit measuring with any greater accuracy, since all optical errors of the image are also enlarged a hundred-fold, the contours grow vague and so on. The accuracy of the projected image is only deceptive. Lengths smaller than $\frac{1}{2}$ wavelength of light (0·2-0·3 μ) are not shown true to life and are not measurable, whilst on an enormously enlarged projected image, measuring is apparently possible with an accuracy up to 0·05 lb. and even more "accurately." It cannot be denied that an efficient micro-projector

is of great value for showing slides objectively to an audience, for drawing or in order to use the planimeter, but for measuring linear lengths it functions no better than any good microscope. For measuring, a projector can therefore be discarded and an ordinary microscope will suffice.

Further it is important how the yield of the trees is determined. In Ashplant's correlation tables the trees are classified according to their latex yield in cubic centimeters. But since for selection purposes the production of dry rubber, which is often not proportional to the latex yield, plays a prominent part. It seems more accurate to judge the trees according to their yield of dry rubber.

Ashplant maintains silence as to the micro-technique with the exception of a remark that only longitudinal selections can be used. It is necessary therefore to work out an independent method. For this investigation 2 methods were tried on material fixed in alcohol (70%).

1. Schulze's maceration method.
2. The eau de Javelle method.

Since the method used by Ashplant is not known, unfortunately comparisons of the figures derived from this investigation with those of Ashplant are necessarily subject to qualification, especially since the yield measurements are based on another principle. The object of this investigation is therefore restricted to investigating the existence of a correlation between rubber production and latex tube diameter.

4. *Objections to the maceration method for the purpose of measuring.* —Although the maceration method is admirably suited to the study of the course of the latex tubes in the bark and for counting the rings, it cannot however come under consideration for the purpose of measuring, since the tubes swell as a result of the treatment and, later on, when the sections are stored in glycerine, gradually become thicker. This is proved by a comparison with measurements of sections treated with eau de Javelle (table I). The sections are derived from the same bark sample; the figures are the average of 100 measurements each.

Table I

Comparison between the maceration and eau de Javelle methods

Position of the trees in Soengei Pantjoer			Diameter of the latex tubes of the bark in μ	
			Maceration method	eau de Javelle method
Block	Row	Tree		
crosses 165 × 161				
8	6	1	26·7 ± 0·30	23·8 ± 0·20
8	6	4	28·2 ± 0·53	27·0 ± 0·36
8	6	6	27·9 ± 0·36	24·7 ± 0·26
marcots clone 180				
9	14	8	25·6 ± 0·34	22·9 ± 0·28
9	14	10	27·6 ± 0·48	23·3 ± 0·25
9	14	12	26·6 ± 0·38	22·7 ± 0·27

It appears from table I, that the macerated sections have much broader latex tubes than those obtained by eau de Javelle procedure; further the maceration method results in considerably large standard deviations.

The trees from block 8 are seedlings from the cross 165 x 161 (see section 8a) and the three trees from block 9 are marcots from clone 180. According to the third hypothesis mentioned in the introduction the latter should have the same width of latex tubes. Whilst this is more or less the case, within the limits of the standard deviation, for the sections treated with eau de Javelle, such a relation cannot be concluded from the maceration method.

After one month a few measurements on the same sections were repeated; the tubes treated according to Schulze appeared to have swollen still more:

Block	Row	Tree	1st measurement	2nd measurement
9	14	8	25·6 ± 0·34	27·1 ± 0·53
9	14	12	26·6 ± 0·38	28·0 ± 0·38

In the sections treated with eau de Javelle only variations within the limits of the standard deviation were found.

It appears from these facts, that the maceration method is impracticable for accurate measurements, whilst on the contrary the eau de Javelle method can be used, if measuring is done within one month. This being always feasible, investigation along this line was discontinued.

In order to know the diameter of the latex tubes measuring shoold be done from cell wall to cell wall. Now this is very difficult if only the cell content is coloured and when hundreds of measurements must be recorded this work is a strain on the eyes. Especially with the maceration method, when the cell walls are nearly indiscernible, the coagulated cell content is measured involuntarily instead of the diameter. But the coagulated rubber is irregularly withdrawn from the cell wall so that the figures found for the diameter of the latex tubes are too small. Sections treated with eau de Javelle can be used much better for staining the cell walls than those treated with potassium chlorate, as the latter disintegrate easily because the tissues no longer cohere.

5. *The method employed for the present investigation.*—After the preliminary investigation had shown that the eau de Javelle method yields better results than the maceration method and that staining of the cell wall is necessary, the following technique was developed. The sections, which should not be too thin (otherwise the latex tubes are torn), are cut with a gliding microtome and treated as follows:

Bleached in eau de Javelle for 1 hour,

Stained in Delafield's haematoxyline for 5 minutes (or less),

Rinsed in water and immersed in glycerine,

Stained in Sudan III for ½ hour,

Rinsed in glycerine.

Eau de Javelle, being unstable in the tropics, is prepared and continually kept fresh in the following manner: chroline is generated from pyrolusite and concentrated hydro-chloric acid and led through a dilute solution of potassium hydroxide (10-15%). Since chlorine is liberated at tropical temperatures heating is not necessary. In this way it is possible to obtain a slight and fairly regular flow of chlorine from granulated pyrolusite (manganese dioxide), which is led day and night through the potash lye in a fumecupboard. In this way a strong eau de Javelle is always available, bleaches the sections within one hour.

Sudan III is prepared according to the formula of Bobilioff and Delafield's haematoxyline according to Strausburgher.

When the sections are satisfactorily stained the walls of the tubes are intense blue and the coagulated cell content a brilliant red. It is then clearly seen that the cell content is irregularly withdrawn from the cell wall. Therefore alcohol (70-90%) is not an ideal fixative for the system of latex tubes. The whole cavity was always measured from cell wall to cell wall.

6. *Anatomy of the petiole of Hevea.*—Preparatory to carrying out measurements on a large scale an investigation into the anatomy of the petiole was considered indispensable, since that is missing in Bobilioff's paper and Asphlant has not investigated whether the system of latex tubes in the bark of the stem is different; neither does he mention that two kinds of latex tubes occur in the leafstalk.

It follows from the anatomical investigation, that only the tubes between the tissue of the pericycle and the wood cells should be considered for measuring. Since these tubes have been formed in a different manner (according to their origin they are to be considered proto—or metaphloëm elements) to the latex tubes of the stem bark (secondary phloëm elements), it is anatomically incorrect off hand to consider the former equivalent to the latter.

3. MEASUREMENTS MADE

A Zeiss microscope with objective D (=40) and compensating ocular 18 as ocular micrometer were used for measuring. One interval of tbe micrometer corresponded to 4·7 μ. Since the diameter of the latex tubes varies considerably, it was especially necessary to know the number of measurements required for a reliable average. Ashplant used the average of 120 measurements; but since he does not give standard deviations, no idea of the extent of the variation of the diameters of the tubes is obtainable. Each of the figures in the following tables is the average of 100 measurements; it appears from the standard deviations that this number is sufficient. Quite valueless averages would be obtained, however, if, in order to save time, less numerous measurements were taken, for instance 10. In this case the standard deviation would increase threefold, so that the averages in table II would not represent an actual difference.

7. *Measurements in leafstalks of buddings of known clones.*—Of course the most remarkable statement of Ashplant, that seedlings scarcely 6 months old with large tubes will become good yielders when tappable, is impossible of verification at present. On the other hand this could be done with 6 months old buddings from known clones. For this purpose leaves were harvested in the nurseries from the AVROS-clones mentioned in tables I and III, fixed in alcohol and after a few days treated as described in section 5. In order to get comparable material the lowest leaves from full-grown internodes were chosen exclusivley.

6 to 10 sections were put on a slide in glycerine. Of course sections which have been cut somewhat tangentially contain more tubes than true radial sections. To begin with, an investigation was carried out to discover whether 100 measurements, made repeatedly in the same preparation, always resulted in the same average.

This preliminary investigation was carried out with two clones and resulted in the following data (see table II):

Clone		Average of the 1st-100th measurement	Average of the 101st-200th measurement
152	...	$17{\cdot}6 \pm 0{\cdot}25\ \mu$	$17{\cdot}7 \pm 0{\cdot}34\ \mu$
180	...	$18{\cdot}1 \pm 0{\cdot}33\ \mu$	$18{\cdot}2 \pm 0{\cdot}34\ \mu$

The averages of each 100 measurements are seen to agree with the limits of the standard deviation.

In order to give an idea of the variations in width of the latex tubes in the leafstalk (and analogously also in the bark), the distribution of each 100 measurements is given in table II arranged in classes of ½ micrometer divisions.

When all measurements in each class are added up, figures are obtained which correspond with a fairly regular Galton's curve. Consequently the material examined does not contain many very large or very small tubes.

In table II the clones are ranked according to the diameter of the latex tubes; the differences are not very marked. But it is very curious, that our contra selection tree, clone 180, which scarcely yields any latex when tapped, possesses the same diameter as clone 36, one of the highest-yielding clones. Unfortunately we do not possess more poor but well-known clones to determine whether this is only a fortuitous exception.

Comparing the diameters with the yields of the various clones, a good correlation is not found (table III). It is true the good clones 256 and 71, as well as the promising clones 183 and 214 head table II, but on the other hand the rather widely varying clones 33, 80, 152 and 163 have the same diameter of the latex tubes, whilst the good clones 49 and 50 come at the bottom of the list and below the indifferent clone 35.

Table II

Distribution of frequency of 100 measurements of the diameter of the latex tubes in leafstalks of known clones. 1 division (d) of the micrometer = 6·7 μ

Clone	d= 2 μ= 9·4	2½ 11·7	3 14·1	3½ 16·4	4 18·4	4½ 21·1	5 23·5	5½ 25·8	Number of measurements	Average in d	Average in μ
256	—	2	9	17	31	22	15	4	100	4·11±0·068	19·3±0·032
183	—	2	13	20	27	26	12	—	100	3·99±0·064	18·8±0·30
71	—	1	10	26	35	16	10	2	100	3·96±0·062	18·6±0·29
214	—	2	15	23	33	16	10	1	100	3·90±0·064	18·3±0·30
36	—	2	14	32	33	14	5	—	100	3·79±0·056	17·8±0·27
152 {	—	—	22	26	37	12	3	—	100	3·74±0·053	17·6±0·25
	—	6	17	30	23	14	8	2	100	3·77±0·070	17·7±0·34
163	—	1	16	37	33	11	2	—	100	3·71±0·049	17·5±0·23
80	—	1	20	33	32	9	5	—	100	3·71±0·055	17·5±0·26
33	1	5	22	24	27	14	7	—	100	3·70±0·067	17·4±0·32
35	—	2	17	38	32	10	1	—	100	3·67±0·049	17·3±0·23
49	2	9	29	24	19	15	2	—	100	3·51±0·067	16·5±0·32
50	—	5	29	34	28	4	—	—	100	3·48±0·048	16·4±0·23
	3	38	233	364	390	183	80	9	1300		
Contra selection tree 180 {	—	5	17	21	30	15	10	2	100	3·85±0·071	18·1±0·33
	—	7	16	20	24	20	13	—	100	3·85±0·073	18·2±0·34
	—	12	33	41	54	35	23	2	200		
Total	3	50	266	405	444	218	103	11	1500		

Table III

Comparison between the yield of known clones (according to Heusser) and the diameter of the latex tubes of the leaf-stalk of 6 months old buddings.

Clone	Number of trees	Grams of dry rubber per tapping year of tapping. 1	2	3	4	5	6	Diameter of the latex tubes of the leafstalk	Position of the trees
63	11	5·5	11·2	23·8	27·6	29·9	31·8	17·4 ± 0·23 μ	Seed garden
35	226	6·8	16·3	18·3	21·7	26·5	—	17·3 ± 0·23 ,,	Tjinta Radja
36	10	4·2	10·0	20·3	24·8	33·2	41·4	17·8 ± 0·27 ,,	Seed garden
49	109	6·2	14·5	21·3	25·6	30·7	—	16·5 ± 0·32 ,,	Tjinta Radja
50	9	6·1	14·7	30·3	34·0	29·5	31·1	16·4 ± 0·23 ,,	Seed garden
71	100	7·8	12·8	21·8	—	—	—	18·6 ± 0·29 ,,	Boekit Maradja
80	50	6·3	12·1	15·2	—	—	—	17·5 ± 0·26 ,,	Boekit Maradja
152	100	9·7	17·1	23·6	—	—	—	17·6 ± 0·25 ,,	Boekit Maradja
163	50	7·8	12·7	20·8	—	—	—	17·5 + 0·23 ,,	Boekit Maradja
183	6	14·8	24·0	—	—	—	—	18·8 ± 0·30 ,,	Soengei Pantjoer
214	10	15·2	—	—	—	—	—	18·3 ± 0·30 ,,	Soengei Pantjoer
256	20	—	—	—	41·7	—	—	19·3 ± 0·32 ,,	Temiang
Contra selection tree 180	26	0·6	1·3	—	—	—	—	18·1 ± 0·33 ,,	Soengei Pantjoer

Ashplant says that all clones from Java, which he examined showed very wide latex tubes; from correlation table VI it appears however, that the diameters of the latex tubes of the examined clones are not very outstanding, with exception of clone 256. The variability in yield of the clones now examined, with exception of the contra selection tree 180, is too small to allow conclusions to be drawn from the figures, the less so since the clones have been tested in different places so that the yield records are not strictly comparable. Therefore the investigation was extended to seedlings of the most widely varying yield classes.

The small variation in yield of the clones coincides with a small variation in the diameters of the latex tubes. It only amounts to 16·4-19·3 μ (as against 14·4-21·2 μ for the seedlings examined, see tables IV and V) whilst nearly all are classed in the groups of 17 and 18 μ (see table VI). Taking into consideration the relatively large standard deviations, which allow only differences of more than 0·5 μ to be considered real differences, judging the clones examined according to the diameter of the tubes (excepted *perhaps clone 256) seems to be without prospects.*

8. *Measurements of latex tubes of seedlings in leafstalk and bark.*— Investigation of tappable seedlings cannot decide the most important problem, to wit, whether Ashplant's method of selection is applicable to nurseries. On the other hand comparative measurements can be carried out in leafstalks and bark, and the correlation between "yield and number of rings of latex tubes" can be contrasted with that between "yield and diameter of the latex tubes."

Leaves were therefore harvested from each tree and at the same time samples were taken of virgin bark at a height of 1 M. The sections of the bark were cut exclusively from the "productive" zone (see section 10), since according to Ashplant a considerable difference exists between the diameter of the latex tubes near the cambium and that of the tubes in the outer zone.

All the seedlings examined were planted in October 1921 as 1-year-old stumps and for the greater part were in the third year of tapping in 1928; all are growing in the Soengei Pantjoer selection garden and their positions are given in the tables.

In tables IV and V the averages of the measurements are calculated at Soengei Pantjoer according to block, row, and tree of the trees examined; for instance 8/12/6 means the sixth tree in row of 12 of block 8. In the following correlation tables (VI-X) all trees are described in the same way; this simplifies looking up the same tree in the various tables. Columns 2 and 3 give the averages of the 100 measurements of tubes in leafstalk and bark with the respective standard deviations. Column 4 gives the ratio between the diameters of the tubes of leafstalk and bark. Columns 5 and 6 give the yield (grammes of dry rubber per tapping) column 5 the average of all three tapping years, and column 6 the average of 1928 (150 tapping days). For the compilation of the correlation tables VI-X the averages of 1928 have been used exclusively since otherwise no comparison with the correlation between number of rings and yield would have been possible, nor could a calculation of the yield per productive ring have been made, because the bark samples taken in the beginning of 1929, can only be used for judging the bark during the last tapping period.

Columns 7 to 10 comprise the number of rings of latex tubes of the bark as specified in section 10. In column 11 the yield of one productive ring has been calculated, and in column 12 that of 1 cm. of productive ring by means of the girth measurements at a height of 1 M., given in column 13; it must be noted that only 1/3 of the circumference is being tapped

In the last column (14) the crossings have been mentioned which were chosen as new mother trees, or which have not yet been tapped for three years for some reason or other (slow growth in thickness etc.). These trees have also been measured in this investigation in order to get a greater variation of yield and circumference. If very divergent figures had been obtained from these trees, tending to obscure the results, it would have been necessary to omit them, but since they do not fall beyond, but within, the limits of the good growers and partly (such as trees 43/2/1 and 43/2/2 in tables VI and VIII) contributed to an improvement of the correlation, they have been inserted in the correlation tables VI-X.

a. *Crosses of the family 165 x 161.*—Widely varying yielders are found amongst the crosses of mother tree 165 with No. 161 as father tree. Unfortunately only 4 trees of this cross have reached tappable age, and one is so backward, that it is not considered in this investigation. It appears from table IV, that the large differences in yield coincide with an appreciable variation of the diameter of the latex tubes. Of all examined trees, tree 8/6/4 which has been chosen as a new mother tree 317, has the widest latex tubes (and also for that matter the greatest number of productive rings).

b. *Crosses of the family 157 x 166.*—In the second place 12 trees of cross 157 x 166 with as widely varying yields as possible were measured. Two of these trees have been chosen as new mother tree on account of the satisfactory yield (8/12/11 = mother-tree 292 and 8/12/4 = mother-tree 293); their latex tubes do not stand out with a very large diameter.

c. *Kampong trees.*—An insufficient number of poor yielders occurring amongst the artificial crosses, measurements were taken of 14 of the kampong trees which have been planted in Soengei Pantjoer for comparative purposes. Trees 43/2/1, 43/2/2 and 43/2/9 are backward, or for other reasons have been tapped only one year.

9. *Results of the measurements of the diameter of the latex tubes.*—The ratio between the latex tubes of the leafstalks and those of the bark yields the most important results. Ashplant takes for granted that trees with large tubes in the bark also possess large tubes in the leafstalk, but this assumption is not substantiated by a single figure. According to a report of a planters' meeting the existence of such a correlation would be immaterial to him.

Table IV

Diameter of the latex tubes and of yield artificially crossed trees.

Position in Soengei Pantjoer block/row/tree 1	Diameter of the latex tubes in μ: leafstalk 2	Diameter of the latex tubes in μ: bark 3	Ratio leafstalk/bark 4	Production in grammes of dry rubber per tapping: 1926/28 5	Production in grammes of dry rubber per tapping: 1928 6	Number of rings of latex tubes: total 7	Number of rings of latex tubes: within 1·0 m.m. 8	Number of rings of latex tubes: productive 9	Number of rings of latex tubes: hard bark 10	Production 1928 of 1 productive ring 11	Production 1928 of 1 cm productive ring 12	Circumference at 1 m height in cm. 13	Remarks 14
				Cross 157 × 166									
8/12/1	16·4±0·19	26·3±0·35	0·63	15·6	23·7	27	6	17	4	1·39	0·055	76	—
2	18·3±0·15	26·6±0·31	0·69	12·5	17·0	37	15	16	6	1·06	0·045	71	—
3	16·1±0·19	26·5±0·31	0·61	16·6	19·2	37	12	19	6	1·01	0·035	81½	—
4	18·2±0·21	26·9±0·34	0·68	24·4	34·6	36	12	20	4	1·73	0·065	79½	Mother-tree
5	16·3±0·15	27·3±0·34	0·60	23·1	28·8	38	13	23	2	1·25	0·056	66½	—
6	17·3±0·22	26·4±0·4[illegible]	0·66	26·5	32·5	31	12	17	2	1·91	0·079	73	—
7	17·4±0·17	24·8±0·38	0·70	22·9	34·9	23	9	12	2	2·91	0·140	62½	
8	17·5±0·23	25·7±0·38	0·68	21·9	32·0	23	10	11	2	2·91	0·127	68½	
9	17·0±0·19	25·3±0·35	0·67	14·7	20·0	28	11	13	4	1·54	0·070	66	
10	17·7±0·20	25·6+0·27	0·69	24·1	32·7	24	10	11	3	2·98	0·144	62	
11	17·4±0·24	25·1+0·31	0·69	36·6	49·3	33	9	21	3	2·35	0·085	83	—
14	17·8±0·30	24·6±0·28	0·72	5·4	6·0	24	10	12	2	0·50	0·036	41½	Mother-tree 292 Tapped 2 years only
				Cross 165 × 161									
8/6/1	17·6±0·29	22·8±0·20	0·74	9·1	12·2	24	7	14	3	0·87	0·031		
4	21·2±0·28	27·0±0·36	0·78	51·3	91·9	36	8	24	4	3·82	0·141		Mother-tree 317
6	17·2±0·34	24·7±0·26	0·70	12·2	19·7	20	88	10	2	1·97	0·095		

Table V

Diameter of the latex tubes and yield of Kampong trees.

Position in Soengei Pantjoer block/row/ree 1	Diameter of the latex tubes in μ leafstalk 2	Diameter of the latex tubes in μ bark 3	Ratio leafstalk/bark 4	Production in grammes of dry rubber per tapping 1926/28 5	Production in grammes of dry rubber per tapping 1928 6	Number of rings of latex tubes total 7	Number of rings of latex tubes within 1.6 mm 8	Number of rings of latex tubes productive 9	Production 1928 of hard bark 10	Production 1928 of 1 productive ring 11	Production 1928 of 1 cm productive ring 12	Circumference at 1 m height in cm 13	Remarks 14
43/2/1	14·4±0·27	25·8±0·27	0·56	3·3	3·3	15	7	5	3	0·66	0·035	57½	Tapped 1 year only
2	15·8±0·26	25·6±0·23	0·62	2·1	2·1	12	7	2	2	1·05	0·056	56	Tapped 1 year only
3	18·2±0·31	21·9±0·23	0·83	6·8	8·8	18	5	11	2	0·80	0·029	84	—
4	15·7±0·23	22·8±0·24	0·69	5·5	7·0	24	10	12	2	0·58	0·029	60	—
5	14·5±0·25	22·2±0·25	0·65	5·0	5·2	15	5	8	2	0·65	0·026	76	—
6	19·1±0·31	26·0±0·33	0·73	4·7	7·7	19	9	8	2	0·96	0·044	66	—
7	17·2±0·28	22·6±0·24	0·76	6·5	8·0	18	7	9	2	0·88	0·040	66½	—
8	17·7±0·35	24·6±0·28	0·72	7·0	6·8	18	5	9	4	0·75	0·026	87½	—
9	17·0±0·30	25·0±0·25	0·68	5·3	5·3	21	7	12	2	0·44	0·017	76	Tapped 1 year only
10	16·2±0·28	24·7±0·23	0·66	7·2	9·2	26	11	10	5	0·92	0·031	88	—
11	14·9±0·26	23·6±0·25	0·63	5·1	7·4	15	5	8	2	0·92	0·041	66½	—
12	18·2±0·33	24·3±0·27	0·75	12·5	19·2	26	12	12	2	1·60	0·079	60½	—
13	16·7±0·24	24·2±0·21	0·69	4·4	3·6	15	4	7	4	0·51	0·021	73	—
14	17·4±0·27	25·4±0·25	0·68	2·3	3·3	16	5	9	2	0·36	0·018	61½	-

As appears from tables IV and V (column 4) the assumption is correct with certain limits. But all the same variation from 0·56 to 0·83, or 32·5%, in the ratio diameter of leafstalk tube 1 diameter of bark tube in table V is noteworthy, whilst table IV shows a more constant ration (variation 0·61 to 0·78). The average of all 29 relative figures is 0·689 ± 0·010; this is therefore the factor for an approximate calculation of the diameters in the leafstalk from those in the bark or vice versa.

Compiling correlation tables from the data in the tables IV, and V, a striking correlation between the diameter of the latex tubes and the yield is not found. Correlation table VI represents the measurements of leafstalks in correlation with the yield. The data concerning buddings from table III have also been used for the compilation of this table, using the yields of the third year of tapping, as with the examined seedlings. For clones 180, 183, 214 and 256, *yield measurements not being available for the* third tapping year, the yields are extrapolated. The seedlings are indicated by their position in Soengei Pantjoer (for mother-trees the selection number is also given in parenthesis), whilst the clone numbers are indicated by cl.

Correlation table VII gives the diameter of the bark tubes. Here again the correlation is bad. Comparison of correlation table VII with correlation table VIII, in which the number of rings of latex tubes has been compiled, is not in favour of the former. As it was the object of this investigation *to find a better correlation for the identification of good yielders than the* usual, unsatisfactory correlation between yield and number of latex tubes, it seemed only a loss of time to continue the measurements. Rather a better arrangement of the data gathered thus far should be attempted and the fundamental idea of Ashplant and the considerations set forth in section 2 should be probed for possible fundamental errors.

10. *Rings of productive tubes.*—First an attempt was made to calculate the yield per tapped ring of latex tubes, as done by Ashplant in his second correlation table.

Taking into consideration only the productive rings, *i.e.*, the rings which are actually opened by tapping and contain latex which can flow out, should result in a better correlation. Haigh has also drawn attention to the fact that the bark zone of ± 1·6 mm. near the cambium is not *touched by the tapping knife. But in the actually tapped bark there are* also rings which do not yield since the contents are coagulated. Haigh tried to investigate this by means of a micro-chemical process, but this yielded peculiar results. Perhaps it would be better to ascertain this from physiological considerations. Bobilioff has already drawn attention to the fact that the tubes in the hard bark are in less favourable condition than those in the soft bark. According to Zimmermann and Arisz the latex tubes, when tapped must absorb water. This water is supplied from the wood through the medullary rays. It is evident, therefore, that a tube which is separated from the soft bark by a closed sclerenchymatous ring cannot function normally since the water supply is interrupted. In the same way rings, which are interrupted by *sclerenchyma do not function* well, since the change of turgor in the mantle of latex tubes, caused by the tapping cannot be evenly transmitted through the whole system of tubes. The latex flow from such tubes will therefore gradually decrease to nil; besides, it can be seen also when the tapping is very shallow, that the latex in the outer rings is coagulated.

In this treatise, therefore, as productive rings are considered those rings, which are situated between 1·6 mm. from the cambium and those which are interrupted or totally separated from the soft bark by sclerenchyma (see columns 7-10 in tables IV and V).

Table VI

Correlation between yield (3rd year of tapping) and diameter of the latex tubes of the leafstalk.
Correlation coefficient $+0{\cdot}54 \pm 0{\cdot}11$. *Yield in grammes of dry rubber per tapping.*

Diameter of the latex tubes of the leafstalk in μ	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
14	43/2/1	43/2/5 43/2/11																		3
15	43/2/2	43/2/4																		2
16	43/2/13	43/2/10		8/12/3	8/12/1 cl. 49	8/12/5	cl. 50													7
17	43/2/14	8/12/14 43/2/7 43/2/8 43/2/9	8/6/1	8/6/6 cl. 35 cl 80	8/12/9 cl. 33 cl. 36 cl. 152 cl. 163		8/12/6 8/12/7 8/12/8 8/12/10			8/12/11 (=292)										19
18	cl. 180	43/2/3		8/12/2 43/2/12	cl. 71	cl. 214	8/12/4 (=293 cl. 183													8
19		43/2/6					cl. 256													2
20																				0
21																			8/6/4 (=317)	1
	5	10	1	6	8	2	8	0	0	1	0	0	0	0	0	0	0	0	1	42

Table VII

Correlation between yield (3rd year of tapping) and diameter of the latex tubes of the bark. Correlation coefficient +0 49 ± 0 14. Yield in grammes of dry rubber per tapping.

Diameter of the latex tubes of the bark in μ	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
21		43/2/3																		1
22		43/2/4 43/2/5 43/2/7																		3
23		43/12/11	8/6/1																	2
24	43/2/13	8/12/14 43/2/8 43/2/10		8/6/6 43/2/12			8/12/7													7
25	43/2/1 43/2/3	43/2/9			8/12/9		8/12/8 8/12/10			8/12/8 (=292)										8
26		43/2/6		8/12/2 8/12/3	8/12/1		8/12/4 (=293) 8/12/6													6
27																			8/6/4 (=317)	2
	4	10	1	4	2	1	5	0	0	1	0	0	0	0	0	0	0	0	1	29

Table VIII

Correlation between yield (3rd year of tapping) and number of productive rings of latex tubes. Correlation coefficient +0·75 ± 0·8. Yield in grammes of dry rubber per tapping.

Number of productive rings of latex tubes at 1 M height	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
0	43/2/2																			1
4	43/2/1 43/2/13																			2
8	43/2/14	43/2/3 43/2/5 43/2/6 43/2/7 43/2/8 43/2/10 43/2/11		8/6/6			8/12/8 8/12/10													11
12		8/12/14 43/2/4 43/2/9	8/6/1	43/2/12	8/12/9		8/12/7													7
16				8/12/2 8/12/3	8/12/1		8/12/6													4
20						8/12/5	8/12/4 (=293)			8/12/11 (=292)										3
24																			8/6/4 (=317)	1
	4	10	1	4	2	1	5	0	0	1	0	0	0	0	0	0	0	0	1	29

The correlation between the diameters of the latex tubes should he improved by the calculation of the yield per productive ring since the dynamical considerations of section 2 do not apply to the other rings. Further the influence of the differences in the circumsference can be eliminated by dividing the yields per productive ring, corresponding with the length of the tapping cut, by 1/3 of the circumference; in this way the yield per 1 cm. of productive ring is obtained. In this manner the factors (n') and (o) are eliminated from equation (3) and consequently the influence of the diameter, which occurs in the fourth power, should be increasingly manifested.

The correlation tables IX and X contain the data calculated in this way. The measures taken have not improved the correlation, on the contrary, as more changeable factors are eliminated, the correlation becomes worse. This appears from tables VII, IX and X and the following table in which, besides the correlations of the tables VI-X, the correlation coefficients between the diameters of the tubes of the leafstalk and the converted production figures have also been inserted.

In connection with the large standard deviations there is no real difference between these diameter correlation coefficients. Nevertheless it is noteworthy that they become systematically smaller and the standard deviations increase proportionally when trying to improve the correlation by calculation of the yield per productive ring or per 1 cm. productive ring. This in contradiction to what might bave been expected, and also with Ashplant's results, who, when calculating the yield per productive ring according to bis metbod, finds a considerably better correlation (+0·83) than for the total yield (+0·76).

Table IX

Correlation between the yield of one productive ring and the diameter of the latex tubes of the bark. Correlation coefficient $+0{\cdot}41 \pm 0{\cdot}15$. *Yield (grammes of dry rubber per tapping) per productive ring.*

Diameter of the latex tubes of the bark in μ	0·2	0·4	0·6	0·8	1·0	1·2	1·4	1·6	1·8	2·0	2·2	2·4	2·6	2·8	3·0	3·2	3·4	3·6	3·8	
21				43/2/3																1
22		43/2/4	43/2/5	32/2/7																3
23				8/6/1 43/2/11																2
24		8/12/14 43/2/13	43/2/8	43/2/10				43/2/12	8/6/6					8/12/7						7
25	43/2/14	43/2/9	43/2/1		43/2/2		8/12/9				8/12/11 (=292)			8/12/8 8/12/10						8
26				43/2/6	8/12/2 8/12/3	8/12/1		8/12/4 (=293)	8/12/6											6
27						8/12/5													8/6/4 (=317)	2
	1	4	3	6	3	2	1	2	2	0	1	0	0	3	0	0	0	0	1	29

Table X

Correlation between the yield per 1 cm. productive ring and the diameter of the latex tubes of the bark. Correlation coefficient + 0·36 ± 0·16. Yield (grammes of dry rubber per tapping) per 1 cm. productive ring.

Diameter of the latex tubes of the bark in µ	0·014	0·021	0·028	0·035	0·042	0·049	0·056	0·063	0·070	0·077	0·084	0·091	0·098	0·105	0·112	0·119	0·126	0·133	0·140	
21			43/2/3																	1
22		43/2/5	43/2/4	43/2/7																3
23			8/6/1	43/2/11																2
24		43/2/8 43/2/13	43/2/10	8/12/14						43/2/12		8/6/6							8/12/7	7
25	43/2/9 43/2/14			43/2/1			43/2/2		8/12/9		8/12/11 (=292)						8/12/8		8/12/10	8
26				8/12/3	8/12/2 43/2/6	8/12/1		8/12/4 (=293)		8/12/6										8
27							8/12/5												8/6/4	2
	2	3	4	5	2	1	2	1	1	2	1	1	0	0	0	0	1	0	3	29

Correlation between	Production 1928	Production 1928 of one productive ring	Production 1928 of I cm Productive ring
Diameter of the latex tubes of the leafstalk	+ 0·50 ± 0·11	+ 0·50 ± 0·14	+ 0·44 ± 0·15
Diameter of the latex tubes of the bark	× 0·49 ± 0·14	+ 0·41 ± 0·15	+ 0·36 ± 0·16
Number of productive rings of latex tubes	+ 0·75 ± 0·08	—	—

On the other hand it is found, in agreement with Ashplant, that the leafstalk gives a better correlation than the bark. This is rather strange, since the latex must flow through the tubes of the bark and not through the leafstalk. If other investigators also find a better correlation for the leafstalk, then Ashplant has indeed found a very remarkable relation between anatomy and yield, which will not be easily explainable. Ashplant considers the bark unsuitable for measurements since he could not find a constant diameter in the bark. By measuring exclusively in the productive zone constant averages were obtainable in this investigation; the standard deviations only slightly exceed those of the leafstalk (the average of all standard deviations of the seedlings amounts to 0·25 μ for the leafstalk and to 0·29 μ for the bark). On the other hand the variations of the averages of the latex tubes in the bark, taking into consideration their larger diameter, is relatively smaller as compared with the tubes of the leafstalk. It is possible that this or unknown errors in measuring, or both, prejudices the correlation of the bark tubes as compared to the leafstalk tubes.

The correlation coefficients derived from the examined material are all so small that no value can be set upon them. Especially they do not bear comparison with the correlation coefficient 0·75 between yield and number of rings of latex tubes. Since only productive rings have been considered this coefficient should not be directly compared with that of Bobilioff (+ 0·55 ± 0·05). Besides the difference in the numbers of examined trees is much too large (29 as against 491).

Little as the coefficients of the diameter imply it is still instructive to make a closer study of the tables. It appears from tables VI and VII that the trees with smallest tubes yield poorly and those with the widest tubes yield very well. But this hypothesis is not reversible, since there are many trees with large tubes which yield indifferently or even poorly; they are to be found in the table in the lower left square.

The possibility exists that the correlation is not a proportional one, the data not being arranged along a straight line but in a triangle; in connection with the paucity of data this possibility should be expressed with the necessary reserve. If curves are constructed from the correlation tables the diameter groups form a symmetric curve; the yield groups however form a very symmetric curve with a considerable accumulation at the left side.

It follows from the tables, that there are trees which yield less than might be expected from the diameter of their tubes, whilst on the other hand there are no trees which yield above their diameter. It can be stated therefore, that a small diameter of the tubes limits the yield of rubber, but that a large diameter gives no certainty that the tree will be a good yielder. (Something of the same kind applies, to a lesser degree, to the number of rings of latex tubes; see table VIII).

A large diameter of the latex tubes is an essential condition for, but unfortunately no proof of a high-yieding tree.

3. REASONS WHY NO EXACT RELATION BETWEEN THE DIAMETER OF THE LATEX TUBES AND THE YIELDS EXISTS

11. *Network of the latex tubes.*—Actuallly equation (3) applies to straight capillaries; it has been mentioned already therefore that it can be considered only as approximate for the flow of latex. There are however cases where it cannot be considered at all.

In tbe bark sections of some trees the latex tubes do not run through continuously, but are often interrupted, since many tubes are culs-de-sac. In this bark the latex must be repeatedly pressed through the anastomoses which have a much smaller diameter. Contraselection tree 180 for instance has this kind of bark. It goes without saying that such a tree must be a poor yielder even if the tubes are very wide.

In contrast to clone 180, clone 183 for instance possesses fine straight uninterrupted tubes which guarantee a satisfactory flow of latex. Of course a tree with such tubes fulfils the theoretical requirements much better. Therefore an examination of the bark should always be carried out besides measuring the diameter of the tubes.

It is also possible that the latex flow is not controlled by the average diameter of the tubes, since the flow must be impeded where in the length wider tubes are connected by smaller ones. In this instance the flow would be controlled by the narrow tubes, and the average of the measurements would be much less important than the minimum diameters.

12. *Distribution of the caoutchouc in the latex tubes.*—In some bark sections slightly stained with Sudan it was noted, that the walls of the latex tubes are covered with a dense layer of coagulated caoutchouc, whilst the middle of the cell remained transparent. According to Dr. Heusser staining with Nile blue makes this more clearly visible.

Unfortunately it was not possible to ascertain whether this is only a peculiar coagulation phenomenon, or corresponds to the natural condition of the tube contents. The objections to alcohol as a fixative have already been mentioned; the important problem whether or not a central area with less caoutchouc particles occurs in the tubes, must therefore be left out of discussion. Nevertheless attention should be drawn to the possibility, that a peripheral layer of more concentrated latex exists. In this case a further condition of the law of Poisseuille would not be fulfilled, *i.e.*, that the liquid should be homogeneous. Perhaps the concentration of the latex depends on the thickness of this layer.

13. *The productive power depends on physiological factors.*—Ashplant concludes from his investigation, that the latex yield is only a lesser degree dependent on physiological factors, but is especially controlled by the diameter of the latex tubes. As proof manuring experiments are brought forward, which showed practically no increase in yield. On the other hand there are many successful manuring experiments on certain soils of Sumatra's east coast, which gave a considerable increase in yield. Besides all planters know that trees which are afflicted with disease can suddenly produce twice their normal dry rubber yield and more, though the latex in this instance has a lower concentration.

It cannot be denied therefore that physiological conditions, which influence the yield, exist. This is to be expected, for what is the use of a tree having large tubes if the latex does not flow out on account of an abnormal dilution reaction caused by some physiological influence, or if regeneration does not occur, or the quantity accumulated in the whole system is inadequate to keep up a continuous flow through large tubes, or indeed if the turgor in the bark is insufficient, etc. ?

Certainly no more can flow through a tube than the diameter allows, but rather less. This is the reason then that so many trees appear in the lower left square in the correlation tables (VI, VII, IX, X). The same reasoning also applies to the number of rings of latex tubes. This cannot be concluded from the correlation coefficients, but can only be deduced from the tables. Publication of correlation coefficients without tables is therefore not sufficient. There is also another problem, very important in practice, which is not explained by Ashplant's theory. The diameter of the tubes remaining constant during the whole life of a tree, the increase in yield, controlled above all by the diameter when the tree grows older, should be the same for all trees. However, this is by no means so. There are clones and individual trees which show an increase in yield proportionately to the age, such as the clone 36, the annual increase during 6 years amounting to ± 7 grammes or the tree 8/12/7 (see table IV) with an annual increase of 11·6 grammes on an average. But there are also clones and trees which for unknown reasons decrease (for instance clone 80 and mother-tree 293) or increase, such as the clone 53, which in the third year of tapping suddenly changed from an underestimated to a satisfactory clone. If these differences cannot be explained by remarkable differences in the forming of new rings of latex tubes by the cambium, they must be set down to physiological causes.

It appears from the data, which could be supplemented, that the physiological tendency and condition of a tree should not be left out of consideration when estimating its yield. This tendency is controlled by a complicated reciprocal action of many factors, and is inherited by the offspring. This is proved by the artificial crosses of Heusser. On the other band the tube bore test is only concerned with a single anatomical characteristic, the predominant influence of which could not be corroborated. For the time being planting good selected seed (from isolated seed gardens) seems more promising than choosing by means of the tube bore from a mixture which besides good yielders also contains physiologically bad yielders.

CONCLUSIONS FOR PRACTICE

It follows from these investigations, that trees with very narrow tubes can be recognised as poor yielders. Therefore the question immediately arises, whether the tube bore test can come under consideration for the selection of Hevea.

For estate practice it seems impracticable to carry out this work systematically and uneconomic also, since a number of trees with large tubes can be disappointing later on. Besides it has not yet been proved that seedlings have a constant tube bore from the earliest youth onward. It has been shown in this treatise, that 6 months old buddings of proved clones have moderately wide to wide tubes, but as is known seedlings differ from buddings in some respects.

Is it possible to use the diameter test as set forth in this paper for the selection work of the experimental stations, to eliminate as early as the nursery stage, from a given population from one pair of parents the disappointing individuals which always occur ? The objection at once arises that it has not yet been proved that seedlings, before planting in the field, already possess the tube bore characteristic of tappable age. In any case the method seems to have no future, since apparently the selection methods so far practised have already eliminated the trees with narrow tubes. Of the examined crosses (table IV) not one has such narrow tubes that it could be rejected without hesitation, whilst this could have been done with some Kampong trees (table V). Table VI shows that the material (clones and crosses) selected by the usual methods can all be classed in the groups exceeding 16 μ. The classes of 14 and 15 μ have disappeared for this planting material. Carrying on selection within such a population seems rather hopeless, since the differences become too small.

Unselected plantation seeds would give populations from which the worst yielders could be eliminated according to the diameter test, but at present it is rightly considered antiquated to use such seed as planting material, except for use as buddings-stocks. In the present state of the Hevea selection hardly any benefit can be derived from Ashplant's discovery, following the methods here set forth.

SUMMARY

From Ashplant's publications 3 hypotheses were inferred. A method for the preparation of the sections has been worked out which guarantees constant results of the measurements. The necessity of giving the standard deviations of each series of measurements must be stressed, since the diameters of the latex tubes vary considerably.

The third hypothesis, the constancy of the diameter of the latex tubes from the 6th month, and the heritability of this could not be checked, since such an investigation would last years.

The second hypothesis, according to which trees with large bore tubes in the bark also possess wide tubes in other parts, could be corroborated to a certain extent. The ratio between the diameter of the bark tubes and that of the leafstalk tubes varies in the examined material from 0·56 to 0·83 with an average of 0·686 ± 0·010. In this connection it should be mentioned that the ratio is more constant in known crosses (table IV, column 4) than in Kampong trees (table V, column 5).

At present *the first hypothesis, the relation between the diameter of the* latex tubes and the yield in grammes of dry rubber, is the most important for selection in Hevea, since the planters are anxiously awaiting reliable data on this problem. From the data here compiled the following may be concluded :

1. A certain relation, but no satisfactory correlation, exists between the *diameter of the latex tubes and yield in grammes of dry rubber.*

2. Trees with narrow tubes are poor yielders, but trees with wide latex tubes are by no means always good yielders of rubber. This appears from the correlation tables VI, VII, IX and X, in which many trees are placed in the lower left square.

3. *It is true that generally speaking the best yielders of dry rubber have wide tubes, but the converse is not true. Consequently the prediction* of the future production exclusively on the diameter of the latex tubes is rather dubious.

4. There are two reasons why trees with large tubes can be poor yielders :

   a. The anatomy of the bark does not satisfy the theoretical requirements, as many tubes end blindly instead of running through. Perhaps the narrowest tubes exert more control than the average diameter.

   b. Consequent on known or as yet unknown physiological causes the tree does not reach the maximum yield (insufficient accumulation of latex in the whole system, unsatisfactory regeneration, absence of the dilution reaction on tapping, etc.). In this instance an increase of yield by manuring may be expected.

5. In the examined material the correlation between tube bore and yield of rubber is worse than that between number of rings of latex tubes and yield.

6. *It appears from the correlation table* VIII *that something similar* to that mentioned (2) and (3) for the diameter of the tubes applies to the number of rings of tubes. The causes given (4) may be brought forward for the explanation of this relation.

7. As regards the trees examined the diameter method is of no more value than counting the rings of tubes. Both methods are handicapped by the same fault, viz. a finely developed system of tubes is not necessarily accompanied by more than normal yield power. The yielding power however is inscrutably hidden in the finer physiology of the Hevea tree.

RUBBER SEED CAKE AS A FEEDSTUFF*

ALTHOUGH experiments have been conducted for several years in the use of rubber seed for crushing, the seed was not used in this country commercially until 1929, when owing to the world shortage of flax-seed occasioned by the extremely short crops in Argentina and the United States for that year, and the resulting high prices, the Hevea rubber nut or seed was one of the substitute seeds to be brought into some prominence.

The rubber nut of commerce is the seed of the cultivated rubber tree grown on plantations throughout the Netherlands East Indies and British Malaya. Production is estimated at about 50,000 tons annually, of which some 30,000 tons are produced in British Malaya. Sumatra and Java together produce approximately 175,000 tons and the rest is produced in other islands of the Netherlands East Indies.

The trade estimates that 1930 imports will amount to about 3,500 tons, which is expected to he increased to at least 10,000 tons in 1931.

Rubber seed when crushed produces about 44 per cent. of oil, 50 per cent. cake or meal, and there is approximately 6 per cent shrinkage. The oil is said to be used as an edible oil, and in making soap, linoleum, and paint and has practically the same analysis as soybean oil.

The Virginia Polytechnic Institute, in conjunction with the Virginia Agricultural Experiment Station, has recently issued a bulletin on Feeding Hevea Rubber Seed Meal for Milk Production. This bulletin states that Hevea rubber seed meal is a new high protein cattle feeding concentrate in the United States, having a pleasant odour something like coconut meal. They give the following analysis of recent samples of the meal:

Moisture	5·0-6·0	Per Cent.
Oil	4·4-6·0	,,
Protein	30·0-33·8	,,
Carbohydrates	40·0-44·0	,,
Crude fibre	7·2-12·0	,,
Ash	5·6-6·0	,,

Certain experiments were carried on to determine milk production with dairy cows.

Two groups of cows were used with two cows in each group. The basic ration for each cow was 20 pounds of corn silage and 8 pounds of alfalfa hay daily. Group 1 received 5 pounds of Hevea rubber seed meal and group 2 received 5 pounds of linseed meal daily in addition to the basic ration.

When fed Hevea rubber seed meal, the milk production for both groups totalled 1,937·9 pounds against 1,779·4 pounds when fed with linseed meal; while butterfat production for both groups amounted to 73·1 pounds in contrast to 71·4 pounds.

Experiments were also made in feeding to sheep with satisfactory results.

It appears that the production of rubber seed will shortly begin to offer some competition to linseed, soybean, and other oilseeds, as the value of the oil, cake, and meal begin to be recognized generally.

* By Felix T. Pope, Foodstuffs Division, Department of Commerce, U.S.A., in *The Malayan Tin and Rubber Journal*, Vol. XX, No. 2, January 31, 1931.

COCONUT CULTIVATION IN BRITISH GUIANA*

THE coconut plant is one which has, in different countries, adapted itself to a wide range of conditions. Among the factors which usually are associated with the best crop returns are: a light, friable soil with an alkaline reaction, and annual rainfall of about 70 inches, good surface and sub-soil drainage, regular superficial cultivation.

In British Guiana, coconuts have been established in heavy clay soils acidic in reaction—with the exception of the moderately extensive sand reefs on the east coast, Demerara, west coast, Berbice, and the Corentyne coast or on the peaty or pegassy soils of the Pomeroon; the mean rainfall of the colony varies from 81 to 103 inches; during the rainy seasons the soils are frequently in a water-logged condition over a considerable period; it is not the custom to practise any cultivation except the clearing of undergrowth twice or three times a year in coconut areas.

It can therefore be deducted that the state of the local coconut industry is not satisfactory; nevertheless, the acreage in 1912 in coconut was double that in 1905; export of coconut products in 1929 was nearly 20 times greater than it was 10 years ago, and extension of the crop continues.

Since the coconut has been and is being planted under conditions that are, in certain instances, patently unsuitable, and since the crop has been proved to be remunerative (a fact which is indicated by the extension which has taken place) it may be of some local value to discuss the chief considerations relative to cultivation under the conditions existing in British Guiana.

SOILS

Many coconut cultivations have been established on heavy soils neither through ignorance nor from preference, for probably every local planter has been convinced by experience that a light soil is the most suitable type for coconuts. Coconuts are one of the few permanent crops of those tried that do still give monetary profits in British Guiana. There has been the tendency to increase the area in this crop; the available sandy soils, in comparison with clay, are small; it is thus that a considerable area of the latter type, although known to be less suitable, has been and probably will continue to be planted up in coconuts.

The case of British Guiana is not unique, and there are other countries in which this crop has been established on heavy soils; in such cases, coconuts have proved themselves to be notoriously poor yielders, and can only be cultivated profitably if the greatest attention is paid to estate saniation especially drainage. Under local conditions, the last-named operation is not easy, and is usually expensive. If a proprietor desires to cultivate 400 acres, the cost of empoldering this area (a charge over and above that necessary for internal drainage and one not arising in a naturally drained country) is approximately $8,000·00-$9,000·00 The cost per unit of land, is so high that the proprietor can ill-afford to cultivate a part only of his empoldered area; hence, although the sandy soils occurring only as "reefs" between the clay have been prepared and first planted, ventures have also been made on the clays.

---

* By H. D. Huggins, D.I.C.T.A., in *The Agricultural Journal of British Guiana*, Vol. III, No. 3, September, 1930.

The practice of establishing coconuts on abandoned cane land in British Guiana has been frequently deplored by previous workers, and with justification. It is not conceivable that high yields can be obtained except by very intensive cultural and manurial operations. Nevertheless, cane lands, abandoned though they be, have been already empoldered and the coconut proprietor is relieved of an initial expenditure, which the above figure ($9,000·00 for 400 acres) indicates would normally be appreciably beyond the means of a small cultivator. This appears to be a possible explanation for the persistence in a practice which has been so frequently condemned.

Albeit, there are instances in which this crop has been established under circumstances (*e.g.*, badly drained clays that are frequently flooded) which must inevitably be a cause of failure. Mention must also be made of the pegassy soils which, as in certain cases in the Pomeroon, have been planted with this crop. Experience has shown that the palms under such conditions are short-lived, and that these soils should be avoided.

In short, the position with reference to the selection of land for cultivation is that planting should be done preferably on the sand reefs, but successful crops may be obtained on the clays when the drainage and general sanitation are thorough enough.

SELECTION OF SEED NUTS

Selection as done in British Guiana, is usually not of a complicated nature and consists almost solely of obtaining seed nut from fully mature trees which when nuts are being collected for sowing, appear to be good bearers of a suitable type of fruit. Unfortunately, there is frequently less trouble than this taken, and seed nuts may be merely gathered from the piles of nuts accumulated from an ordinary harvest.

Seed selection is one of the features most deserving of attention in local coconut cultivation. As the area of land occupied per tree is comparatively great and as the crop is of a permanent type, it is essential that the best available planting material be procured.

It is possible that the lack of knowledge of the yield of different varieties, of descriptive characters by which they may be identified, and of the degree to which they may be expected to breed true to type may be factors tending to give the planter little encouragement to attempt selection. The writer assisted in some observations (account unpublished) on the rate at which the inflorescence of 25 coconut palms appeared. These observations were carried on over a period of three months and not once did the opening of male and female flowers coincide on the same plant; on the same inflorescence the female flowers opened 3-6 days after the last male had been shed; new spadices opened up two days onwards after the female flowers (which remain receptive for 24-30 hours) of the preceding inflorescence had opened. The indications are therefore that self-pollination must rarely occur, under these conditions, among the "tall" palms which are the type almost entirely cultivated. Hence, it is apparent that trees which look very much alike will differ constitutionally, and seedlings from the same parent tree will vary, to an extent as yet undermined, on account of cross-pollination.

Nevertheless, there is much which has been gained in coconut cultivation by selection and for practical purposes the following is a system which, if followed, may be relied on to give as good results as may be expected when the present lack of data on coconut-yields is taken into consideration.

The parent trees should be mature, not less than 25 years old, and not more than approximately 40; only trees which are growing under ordinary estate conditions should be chosen, as those observed flourishing near to dwellings, compost heaps on the margins of fields, and in advantageous positions with regard to light and drainage, owe much of their apparent vigour to their favourable surroundings.

The ideal condition would be to have a tree-record by means of which the copra yield of each tree could be known, and, by a process of elimination, ascertain which are the best trees on the estate. This cannot be done hurriedly, nor can it be done economically on a large scale, but the field from which the highest returns are obtained should be selected, every tree in a block of suitable size in that field numbered and a record kept of the number of nuts collected from each tree. Three or four pickings of monthly intervals will give indications of the poorest yielding trees which can be eliminated, and the number retained for observation, considerably reduced. The most prolific trees having been discovered, copra is separately prepared from the ripe nuts of each tree and then the weight of the copra produced per nut estimated.

While the above scheme may be good, it is rather too ambitious to be adopted readily in the system of coconut cultivation which is generally practised in this colony; the following general hints, although less comprehensive, may be more favourably considered and so be of more practical utility:

Select seed nuts from a tree which has short interspaces between consecutive leaf scars that are deep and close together as these characters are indications of regular and heavy bearing. A parent tree should be one containing a large number of leaves (these may vary from about 25 to 40); apart from other reasons, since each leaf normally bears a bunch of fruit in its axil, the greater the number of leaves, the greater will be the number of bunches produced.

Select trees bearing a medium sized rather than a large nut in which the percentage of "meat" is large. It is even preferable to select from the size of the nut rather than from the size of the fruit, for, in some types, the husk is so thick that an erroneous estimate may be made of the size of the nut (and so of meat) within. As to the actual shape of the nut, such divergent views are given that it is probably not a character deserving of too great attention.

NURSERY

This phase of work is of special importance in the local industry, for not only is a nursery used prior to the establishment of a plantation, but the death rate of growing trees is so high that except the cultivated area be very small—the need for replacements necessitates a constant nursery supply.

The system generally adopted here, and which appears to be satisfactory, is to place the selected seed nuts 1 foot × 1 foot apart in the nursery. This is usually situated not far from the main buildings, and, although it might appear that it would be preferable for the nurseries to be closer to the planting sites, the consensus of opinion is that the advantages obtained from easy and constant observations of the young seedlings warrant the continuation of the present custom.

The soil of the nursery should be light and friable, and surface drains about 9-12 inches deep should be dug approximately 8 feet apart in order to give the young plants the necessary drainage. When the weather is dry, light shade (*e.g.*, by means of plaited coconut leaves) or a straw mulch should be supplied to the young plants. Too much shade must, however, be avoided, as otherwise the plants become "leggy" and adapt themselves, with difficulty, to the change in conditions when they are transplanted.

The rainfall in this country is abundant, but is not evenly distributed throughout the year, so that although in some cases seed nuts are merely placed on the surface of the soil of the nursery and light shade placed over them, as is frequently done in localities with high humidity it is usually the custom to cover the seed nuts with soil so that only the top of the nut can be seen above the ground.

It is necessary to make reference to the beetle pest, known as "Cockles" (*Strategus aloeus* L.), which influences the position in which nuts are placed in the nursery. When nuts are "set" in the soil, the usual custom is for them to be placed on their sides in many districts locally, the nuts are invariably "set" upright so that the end with the germ is uppermost. When the latter is done the damage by this pest is said to be more readily detected and control measures more easily applied. A disadvantage when the seed nuts are placed in an erect position, is that the scale leaves tend to harbour fungi and scale insects, and it is generally admitted that, under normal conditions, better results are obtained from planting the nuts on their sides. Nevertheless the ravages of the pest can be severe, often resulting in the complete destruction of the young shoot, and the practical adjustment to conditions persists.

If a nut is examined, it will be observed that there are three sides, and that one is wider than the other two. If planting on the side is practised, the nut should be so placed that the wide segment is uppermost as it is the latter which has the germinating eye. Manure is not generally applied to nurseries locally, nor is the practice considered advisable. The seed is amply supplied with plant food, and manure merely tends to encourage an excessive formation of fibrous roots; also, if organic manures be used, insect pests may be encouraged.

The period during which seedlings should be left in the nursery before transplanting varies. Germination takes place in 3-6 months, and on many plantations the plants are transplanted in 9-12 months. The advantage of planting at such an advanced stage seems to be that selection of the right type of seedling for planting can be made, "leggy" and other undesirable types discarded. There are, however, planters who prefer to transplant at a much earlier age. It is claimed that when the seedings are young (*e.g.*, when the shoot is 12 in.-15 in. high) their roots are less firmly established in the seed bed and so the shock (of transplanting) is not severe; at this stage, as the "meat" has not already all been utilised, the young plant can better withstand unfavourable conditions in the new environment. This latter opinion the writer has heard frequently expressed, especially on the west coast of Berbice, and it is worthy of note that these also have been the conclusions drawn from certain Philippine experiments.

FIELD CULTURE

The seedlings should not be planted closer than 30 feet x 30 feet apart. When conditions permit, the position of the holes should be lined out before the drains are dug. The most desirable system is to practice diamond-shaped planting, each hole being at the corner of an equilateral triangle whose sides are 30 feet long. In this method, the plants are allowed sufficient leaf and root space and there are fifty-six trees per acre. When square planting is practised there are only 48 plants to the acre. This difference is equivalent to about 400 nuts per acre per annum in favour of the diamond or "quicunx" planting. In very many cases, however, coconuts are planted locally on land that was formerly laid out for canes with drains 30-36 feet apart. Diamond-shaped planting (with a spacing of 30 feet) is therefore impossible as the drains will interfere with the layout unless certain rows are planted very close to the drains and this is inadvisable. Square planting is therefore the general rule in British Guiana.

Drains of different dimensions are made in different localities varying as the conditions may demand, but, in general, drains 3 feet wide at the top graded to 2 feet at the bottom and 2 feet deep seem, normally, to be satisfactory; the average cost of digging such drains is about 12 cents per rod.

Nuts are "set" in the nursery so that transplanting may be done in either or both of the rainy seasons (April-July and November-January), but November to December planting is preferred because the dry season

which follows is a short one and the young seedlings will not be exposed to a too prolonged dry period before the April rains begin.

Usually, a hole is dug of such depth that when the seedling is transferred the nut can be just covered with soil. It would, however, be wiser to have the holes more thoroughly prepared. When the beds have been lined, holes (3 feet square and 2 feet deep are recommended) should be dug. The holes should be left open for some time, preferably for 8-10 weeks, and refilled with surface soil so that when seedlings are put in, the nut is a little below the original level of the field. The plant should be placed in the middle of the hole, the space around the nut filled in and the soil firmly pressed down so that there is no depression in the immediate vicinity of the seedling in which water is likely to stagnate.

This soil should be mixed with farmyard manure but the latter, under existing local conditions, would frequently not be available. Nevertheless, this is a critical period in the life-history of the plant, as, in many cases, the plant has ceased to get nourishment from the reserves in the nut, and, moreover, the severing of young roots and the actual operation of transplanting constitute a check which necessitates the application of a quick-acting fertiliser when the plants are set in the field. A mixture which has been recommended in other countries is:

150 lb. Superphosphate.
150 ,, Nitrate of Soda.
50 ,, Nitrate of Potash.

This should be thoroughly mixed and 2 lb. applied to each hole.

The seedlings having been transplanted, the custom is, in British Guiana, to fork around each plant as soon as it is well established (*i.e.*, about six months after). Intertillage is obtained indirectly, for 3-4 years after planting, by the cultivation of catch crops. Such catch crops are usually not planted and owned by the proprietor, but belong to renters. The system of renting young orchard fields to farmers for the growth of quick-growing crops has evidently been adopted both because of the dues received and of the general cultivation which is necessarily given to the soil. In the case of coconuts, however, the disadvantages which result from the breaking in and disrepair of drains, the depressions in the beds caused by the planting in mounds of such crops as potatoes and yams, and the haphazard cultural operations practised by tenants detract more from the value, which should be obtained from such a system, than may at first appear.

The extent and frequency of the cultivation of fields in which coconuts are established are subjects on which divergent views are held and on which a pronouncement for local conditions should be made with caution. It would appear, however, that what evidence there is indicates that the economic advantages to be gained locally from clean cultivation are questionable. Harrison and Stockdale considered that after about six years, coconuts required little cultivation, but that drainage should be attended to and weeds cut down and used for mulching purposes. Dash was of opinion that, under tropical conditions, clean cultivation and no attention to the vegetable matter content of the soil led to disastrous results and that the most successful tropical orchardists had learned fully to appreciate the value of the organic mulch. There are definite figures given for certain estates in Portuguese East Africa where a yield of 0·5 ton of copra per acre is obtained by plantations which practise intensive cultivation as against a yield of 0·2 ton per acre without much cultivation. Three is a difference of 0·3 ton which is equivalent to a gross profit of $24-$30 per acre. This figure seems low, and would not offer sufficient inducement to the local planter to maintain his fields in a high state of cultivation unless the labour supply on coconut estates were much increased and the cost of cultural operations (possibly by the use of implemental tillage) considerably reduced.

On the other hand, it cannot be contended that the almost complete state of abandonment, in which a large percentage of the coconut cultivations in British Guiana is kept, is satisfactory, and a practice which is likely to be profitable is the more general use of green manure crops between the rows of coconut trees. If a vigorously growing crop such as Black Bengal Beans (*Stysolobium atterimum*) were selected, weed control could be very considerably aided, the soil could be protected from the mechanical beating action of rain and from excessive heat of the sun. At intervals, the green material should be ploughed in and incorporated with the soil in the middle of the beds. This would increase the general fertility of the soil and especially the content of humus. Apart from other considerations, the mechanical effect of the decomposed organic material incorporated would be very desirable especially on heavy impervious soils on which this crop has been in many instances planted. It should be noted that that Bengal Beans have been well established they will re-seed the area and that there should normally be no recurrent costs for sowing.

Reference may be made at this stage to the care of surface drains. All drains should receive attention and where necessary re-conditioned every year. The drains should, however, be freed of all weeds and grass not less than three times per year, and stoppages, caused by the collapsing of the sides by excessive silting, removed.

YIELDS AND COSTS

Picking is as a rule done at intervals of 10-12 weeks. The pickers should be experienced, as it is essential that they recognize the fully ripe nuts. A good picker can usually distinguish accurately between the ripe and immature nuts simply by their appearance, but when there is any doubt, tapping with the knuckles is resorted to. The ripe nuts when so tapped emit a hollow sound as against a dull less resonant note by the younger nuts.

The local census returns indicate that the average yield per tree per annum is not much more than 15 nuts. Such a low figure is due to the not inconsiderable coconut area that is in absolute and complete abandonment. Many such cultivations were, at their inception, not thoroughly drained and in unsuitable environment (*e.g.*, heavy clays, pegassy) and as they grew older were deprived of all cultural operations. Low returns could therefore be expected, but there are many coconut plantations on which very much more satisfactory figures are obtained. On the west coast of Berbice and on one estate on the Corentyne, the writer is convinced that the yield is frequently more than 70 nuts per tree per annum and there is an appreciable area on which the normal annual yield is about 40 nuts per tree.

The following yields and costs which are based on figures collected on a number of estates in different parts of the colony may prove interesting:

Yield per acre of moderately good estate approx.	2,000 nuts.
Average of 5,000-7,000 nuts yield ...	1 ton of copra.
Yield of copra from 1 acre	750-800 lb.
180-250 nuts (mixed) give (by existing primitive system of extraction) ...	1 tin or 4 gals. of oil.
Yield of oil from 1 acre	40 gallons (1 drum)
Cost of picking and transporting to yard per 100	16 cents.
Cost of picking, transporting and "peeling" of 100 nuts.	20-26 cents.
(Nuts are always "peeled" when they are sold as such and not converted into copra)	
Cost of peeling per 100	6-7 cents.

Cost of "digging" meat from shell per 100 (Frequently, however, when copra is being made, the nuts are not "peeled" but the husk and shell are broken with a pickaxe in one action, and then the meat removed. By this method, a saving of 40 cents-60 cents per thousand nuts is effected).	6 cents.
Cost of drying 1 ton of copra	$5·12

Copra.—This is the commercial term of the dried meat or kernel of the coconut. Previously, comparatively small quantities of copra were shipped from this Colony, the trade being almost entirely in nuts, but, as the table below indicates, the production of copra has steadily increased.

Annual Exports of Nuts and Copra.

	1907-26 (average)	1927	1928	1929
Nuts (thousands)	1,623	334	322	638
Copra (cwt.)	4,745	23,266	70,017	75,187

In most cases, nuts are picked, but rarely only fallen nuts are collected. Where the latter is practised the operation should be carried on at regular intervals and as complete a collection as possible made each time, otherwise some of the nuts remain on the ground, begin to germinate and give rise to a poor quality copra which is pale and does not possess the characteristic colour of high grade copra. Where, however, the nuts are picked and the practice is recommended they should be stored for some weeks after being picked, as stored nuts give the best quality copra.

Almost all of the copra which was formely produced was sun-dried, but the erection of small hot air dryers is becomnig increasingly common. One of the essentials in copra making is that the kernels do not become wet after drying has started; if this occurs, the copra will not keep, readily develops moulds and becomes rancid. The dry season is neither sufficiently well marked nor normally so prolonged as to permit sun-drying being otherwise than a most uncertain procedure.

The hot air dryers in use are of very simple design. At one end of the dryer a furnace is situated, from which the hot gases are conducted through the furnace by boiler tubes. The gases from the furnace are not liberated in the chamber, but escape through a chimney at the opposite end of the dryer so that the temperature of the air in the chamber is raised through the heating of the tubes. As the kernels must be dried with hot dry air, it is essential that suitable ventilation in the chamber be supplied. This is done in many cases by placing, through the side of the chamber, a tube which helps to connect the interior of the dryer with the atmosphere. If the advice of an engineer, experienced in copra-drying, were available, the efficiency of these dryers could doubtless be considerably enhanced. Until such time, however, as co-operative movements may make it possible or until the average size of the plantation is greatly increased, the present type of machinery is not likely to lose favour, in such circumstances, simplicity and initial expenditure have much influence.

Coconut Oil.—Oil is not made locally from copra. The fresh kernels are removed and grated. Usually, the grater consists of perforated tin placed around a revolving rotary drum which is operated by a low horse power (*e.g.*, 3 h.p.) oil engine. When continuous work is done 200 nuts (*i.e.*, enough to produce one tin or 4 gallons of oil) in 30 minutes is a fair estimate of the rate of grating.

The grated material is then hand-squeezed, a liberal supply of water is added, the mass washed and squeezed again. Approximately 40 gallons of water are used in the washing and squeezing of 200 nuts. The washings are

then settled in drums for about 16 hours. The oil separates, floates on the top, is skimmed off and boiled. The clear oil is strained off and the residue is then subjected to strong pressure, generally by means of a jack-screw.

When the "milk" from 200 nuts is left to stand for 16 hours about 6 gallons of oil and water emulsion are obtained, and this on boiling is reduced to about 4 gallons. Frequently, a small amount of salt is added to the washings as the sodium chloride in solution is said to hasten the settling process. As the oil is a colloid in suspension, it is to be expected that the oil separation would thereby be facilitated.

Little comment is necessary on this method. It is crude, not economical, and the expression of oil is extremely low. A good grade of oil is produced, but the production costs are so high that there is little encouragement to increase the present output.

DISEASES

As a result of planting on unsuitable land in the first instance and subsequent neglect, large numbers of coconut trees in the Colony are lost from wilt disease (formerly known as "bud rot") a condition primarily brought about by unfavourable environmental conditions, and entirely comparable in cause and effect with the "Bronze Leaf Wilt" of coconuts which has recently been engaging attention in Trinidad. Contributory factors to the occurrence of the disease are insufficient nutrient, supply, water-logging, and poor cultivation in general, the latter resulting in a bad condition of the soil and an overgrowth of weeds, which block the drains and compete with the palms to the disadvantage of the latter.

The disease, as mentioned above, is most usually found upon heavy soils, but occasionally appears on sand reefs. The symptoms exhibited by the palm are a yellowing and later bronzing in colour of the leaves, which eventually die and hang down. The outer (*i.e.*, the oldest) leaves are affected first, and then the other leaves follow in succession, the crown of the tree being the last part to lose its green colour. By the time that half to two-thirds of the leaves have died, however, the heart and bud of the tree become involved in a wet foetid rot, which is very evident if an affected tree be felled and the crown split open longitudinally. The bacteria, etc., causing this rot are secondary factors, and only attack the already wilted and weakened tissues.

As regards other diseases, the Red Ring disease, so serious in parts of Trinidad, has only been reported once in this Colony a somewhat doubtful case and is not a factor affecting the crop. One or two minor leaf diseases are known but these are to be found as a rule only upon palms already weakened by other causes. Another disease, the exact origin of which is uncertain, causes a disfigurement of the outer surface of the nut, but does not affect the contents.

Insect Pests.—The four principal insect pests are the Coconut Caterpillar (*Brassolis sophorae*) the Coconut Stem borer (*Castnia daedalus*) the Coconut Beetle or Cockle (*Strategus aloeus* L.) and the Large Locust (*Tropidacris latreille* Perty).

Coconut Caterpillar.—The caterpillars destroy the leaves of the palms at times completely defoliating them. They form "nests" by drawing together several of the leaves on the branches; in these nests they live during the day, emerging at night to feed. They also conceal themselves in the "heart" of the tree. Husk, old branches, "bush," etc., harbour the chrysalises.

For the control of the pest it is necessary to remove completely all such branches and nests and to destroy carefully all caterpillars. Also husks, branches, "bush" and other waste material lying on the ground beneath the trees must be collected together and burnt.

Coconut Stem Borer.—This pest lays its eggs about the leaf-bases of the coconut palm and shortly after the larva emerges, it bores into the stem about the leaf-bases and there remains until fully grown causing in the meanwhile considerable damage to the tree. An attacked tree, when in the advanced stage, shows a peculiar droop of the leaves, bending considerably as if too heavy. In some instances an attack of this kind causes the tree to cease to bear fruit and often proves fatal.

The method of control employed against this pest is the careful removal of all the lower branches by cutting them off as completely as possible from the tree. The "worms" should then be secured and destroyed.

Coconut Beetle or Cockle.—These beetles burrow into the lower stem and rooting system of young coconut palms, and, if not removed, will cause the death of the palm. A sickly appearance of young palms often indicates the presence of the coconut beetle. The large-sized hole made by the entry of these beetles at the base of the palm is easily detected.

This insect can be controlled if dug out, but, when this is done care must be taken not to injure the palm. A better way is to pour a mixture of kerosene and water or naphtholeum and water into the burrow and this causes the beetles to come to the surface where they may be captured and destroyed.

The large Locust.—Both the adult and immature forms of this insect feed on the foliage of the coconut palm, the immature forms being particularly destructive. On the appearance of these pests, unless early steps are taken to have them collected and so prevent their egg-laying, would increase abundantly and cause a great deal of damage to this palm.

These insects are controlled by shaking or sweeping them from the foliage and collecting them in convenient receptacles containing kerosene and water, after which they should be buried or burnt.

EFFECT OF INTERVAL BETWEEN THE MORNING AND EVENING MILKING ON THE QUANTITY AND QUALITY OF MILK*

THE cows at the Imperial Institute of Animal Husbandry and Dairying, Bangalore, are generally milked at 4 a.m. and 3 p.m. throughout the year, thus giving an interval of 11 and 13 hours between the morning and evening, and evening and morning milkings, respectively. Preliminary tests showed that the evening milk was invariably richer though less in quantity as compared with the morning milk. To study the differences more closely, the previous records were studied and an actual experiment was carried out. The results are interesting and deserve some consideration.

Data Obtained from the Previous Records.—Figures, both for quantity and quality of milk for Sindi cows, were compiled, for a complete year, *i.e.*, from June 1927 to May 1928, and are given at the end (table I). The perusal of the figures will show that there was more milk in the morning though it was poorer in fat percentage as compared with the evening milk. The figures for the month of March show almost the same fat percentage, both for the morning and evening. This may be attributed to a little change in the intervals of milkings.

Experimental Procedure.—To verify the data compiled from the records an experiment with 10 half-bred cows was undertaken. The cows were divided into two groups, A and B, and every care was taken to make both the groups as nearly identical as possible with regard to age, milk yield, and period of lactation. To further reduce the experimental error the same milkman was kept with the same group throughout the period. The experiment was carried out for 14 days allowing two days as a transitory period. The milking was done at 4-15 a.m. and 4-15 p.m. for the equal intervals, while, for the unequal intervals, the milking was done at 4-30 a.m. and 3-30 p.m.

The Results Obtained from Groups at Equal Intervals.—To start with group A was milked at equal intervals. The quantity of milk both for the morning and evening was almost the same, *i.e.*, 54·75 lb. in the morning and 54·81 lb. in the evening. The fat percentage was slightly higher in the evening. The total average fat in the morning was 2·262 lb., while in the evening it was 2·329 lb.

After 6 days, when B was changed to equal intervals, it showed practically the same results as obtained from group A. The average milk in the morning and evening was 58·19 lb. and 57·75 lb., with 2·477 lb. and 2·429 lb. of fat respectively.

* By C. N. Dave, B.Ag. (Bom.), Harbans Singh, I.D.D. (Alld.), D.R. Khera, L.Ag. (Hons.), and Chanda Singh, L.Ag. (Hons.), in *The Journal of the Central Bureau for Animal Husbandry and Dairying in India*, Vol. IV, Part III, October 1930.

Now, taking the average of the two groups, it will be seen from the following table that the milk and fat are almost the same, with a very slight increase in the morning in quantity and with a proportionate increase in fat in the evening:

	Group A		Group B		A + B (average)	
	Milk lb.	Fat lb	Milk lb.	Fat lb.	Milk lb.	Fat lb.
Morning	54·75	2·262	58·19	2·477	56·47	2·370
Evening	54·81	2·329	57·75	2·429	56·28	2·380

The results for the equal intervals are given in a detailed form in table II.

Results Obtained from the Groups at Unequal Intervals.—To start with, group B was milked at 4-30 in the morning and 3-30 in the evening. The quantity of milk was more in the morning while the fat percentage was higher in the evening milk, though the total fat was less in the evening, due to the difference in the quantity of milk. After six days, group A, which was being milked at equal intervals during the first period, was changed, to unequal intervals. The results obtained from group A corroborate those of group B at unequal intervals.

	Group A		Group B		A + B (average)	
	Milk lb.	Fat lb	Milk lb.	Fat lb.	Milk lb.	Fat lb.
Morning	57·69	2·299	61·62	2·499	59·655	2·399
Evening	50·81	2·216	53·94	2·331	52·375	2·274

Table III will show in detail the above results, given in tabular form.

It will be clear from table IV that the total out-turn of both milk and fat remain constant for the whole day, irrespective of the interval between milkings.

Conclusions.—1. By keeping equal intervals between the two milkings the total out-turn of milk and fat remain practically the same, although there is a little increase in fat percentage in the evening which may be attributed to the activity of the fat secreting cells during the daytime.

2. The total quantities of milk and fat for the whole day remain almost constant, irrespective of the interval between milkings. This fact is of great importance from a practical point of view.

3. By keeping an unequal interval between the two milkings one can get more milk with the longer interval and richer milk with the shorter interval and can thus arrange the supply of fresh milk and its products according to the local demand.

Table I

Statement (from office records) showing the difference of quantity and quality between the morning and evening milk of Sindi cows.

Month		Average No. of animals in milk		Total milk produced lb.		Average milk produced per head per day lb.		Number of days observed for fat test		Average percentage of fat	
		A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.	A. M.	P. M.
June	1927	28·8	28·9	3,778·5	3,249·0	4·36	3·75	24	22	4·91	5·39
July	1927	25·2	25·1	3,067·5	2,756·5	3·91	3·53	25	25	5·09	5·45
August	1927	43·4	42·8	7,456·5	6,321·0	5·53	4·76	24	25	5·16	5·31
September	1927	42·6	41·2	6,833·0	5,567·5	5·34	4·50	23	22	4·81	5·38
October	1927	40·2	40·0	6,769·5	5,832·0	5·43	4·70	10	5	4·79	5·24
November	1927	41·4	41·4	6,632·5	5,700·0	5·33	4·60	26	28	4·77	5·21
December	1927	44·9	44·9	7,144·0	6,242·0	5·13	4·48	26	28	4·53	5·08
January	1928	43·4	43·5	6,601·5	5,768·5	4·90	4·27	24	24	4·14	4·55
February	1928	42·6	42·6	5,864·0	5,091·5	4·70	4·19	29	24	4·19	4·43
March	1928	41·7	41·7	6,113·5	5,234·5	4·72	4·05	21	19	4·47	4·46
April	1928	41·7	41·5	7,330·5	6,245·5	5·85	5·01	29	17	4·03	4·15
May	1928	37·6	37·7	6,555·0	5,631·0	5·62	4·81	Not available	Not available	Not available	Not available
Total ...		473·5	471·3	74,166·0	63,639·0	60·82	52·65	261	239	50·89	54·65
Average ...		39·5	39·27	6,180·5	5,303·25	5·07	4·39	23·73	21·73	4·63	4·97

Table II

Showing the milk and fat yields of 10 half-bred cows milked at equal intervals.

Date	Group A — 5 cows						Date	Group B — 5 cows						Total of Groups A & B				Average of Groups A & B			
	Morning		Evening		Total			Morning		Evening		Total		Morning		Evening		Morning		Evening	
	Milk	Fat	Milk	at	Milk	Fat		Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat
	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.		lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.
20th March 1930	54 8	2·267	55 8	2·202	110 0	4·469	27th March 1930	58 8	2·437	58 8	2·465	117 0	4·902	113 0	4·704	114 0	4·667	56 8	2·352	57 0	2·338
21st, March 1930	54 0	2·342	55 0	2·360	109 0	4·702	28th March 1930	57 8	2·348	58 0	2·462	115 8	4·810	111 8	4·690	113 0	4·822	55 12	2·345	56 8	2·411
22nd March 1930	56 0	2·246	55 8	2·339	111 8	4·585	29th March 1930	59 8	2·547	58 8	2·408	118 0	4·955	115 8	4·793	114 0	4·747	57 12	2·397	57 0	2·374
23rd March 1930	54 8	2·175	55 0	2·369	109 8	4·544	30th March 1930	58 8	2·442	55 8	2·337	114 0	4·779	113 0	4·617	110 8	4·706	56 8	2·309	55 4	2·353
24th March 1930	57 0	2·402	53 0	2·358	110 0	4·760	31st March 1930	56 0	2·356	58 8	2·501	114 8	4·857	113 0	4·758	111 8	4·859	56 8	2·379	55 12	2·429
25th March 1930	52 8	2·143	55 0	2·350	107 8	4·493	1st April 1930	59 0	2·732	57 8	2·400	116 8	5·132	111 8	4·875	112 8	4·750	55 12	2·438	56 4	2·375
Total	328 8	13·575	329 [illegible]	13·978	657 8	27·553	Total	349 0	14·862	346 8	14·573	695 8	29·435	677 8	28·437	675 8	28·551	338 12	14·220	337 12	14·280
Average	54 12	2·262	54 13	2·329	109 9	4·592	Average	58 3	2·477	57 12	2·429	115 15	4·906	112 15	4·739	112 9	4·758	56 8	2·370	56 4	2·380

Table III

Showing the milk and fat yields of 10 half-bred cows milked at unequal intervals.

Date	Group A — 5 cows						Date	Group B — 5 cows						Total of Groups A & B				Average of Groups A & B			
	Morning		Evening		Total			Morning		Evening		Total		Morning		Evening		Morning		Evening	
	Milk	Fat	Milk	Fat	Milk	Fat		Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat
	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.		lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.
27th March 1930	59 4	2·319	51 8	2·217	110 12	4·536	20th March 1930	63 0	2·657	53 4	2·240	116 4	4·897	122 4	4·976	104 12	4·457	61 2	2·488	52 6	2·229
28th March 1930	57 8	2·243	51 0	2·228	108 8	4·471	21st March 1930	62 8	2·368	55 0	2·423	117 8	4·791	120 0	4·611	106 0	4·651	60 0	2·306	53 0	2·326
29th March 1930	59 4	2·350	53 8	2·365	112 12	4·715	22nd March 1930	62 8	2·583	54 8	2·305	117 0	4·888	121 12	4·933	108 0	4·670	60 14	2·467	54 0	2·335
30th March 1930	57 8	2·405	49 12	2·188	107 4	4·593	23rd March 1930	60 8	2 507	51 0	2·088	111 8	4·595	118 0	4·912	100 12	4·276	59 0	2·456	50 6	2·138
31st March 1930	56 8	2·296	51 0	2·247	107 8	4·543	24th March 1930	61 0	2·434	54 0	2·498	115 0	4·932	117 8	4·730	105 0	4·745	58 12	2·365	52 8	2·373
1st April 1930	56 0	2·179	48 4	2·052	104 4	4·231	25th March 1930	60 4	2·449	56 0	2·433	116 4	4·882	116 4	4·628	104 4	4·485	58 2	2·314	52 2	2·243
Total	346 0	13·792	305 0	13·297	651 0	27·089	Total	369 12	14·998	323 12	13·987	693 8	8·985	715 12	28·790	628 12	27 284	357 14	14·396	314 6	13·644
Average	57 11	2·299	50 13	2·216	108 8	4·515	Average	61 10	2·499	53 15	2·331	115 9	4·831	119 5	4·797	104 12	4·547	59 10	2·399	52 6	2·274

Table IV

Showing the total daily yields of milk and fat from 10 half-bred cows of equal and unequal intervals.

Group A — 5 cows						Group B -- 5 cows						Total of Groups A & B per day				Average of Groups A & B per day			
Equal Interval			Unequal Interval			Equal Interval			Unequal Interval			Equal Interval		Unequal Interval		Equal Interval		Unequal Interval	
Date	Milk	Fat	Date	Milk	Fat	Date	Milk	Fat	Date	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat	Milk	Fat
	lb. oz.	lb.		lb. oz.	lb.		lb. oz.	lb.		lb. oz.	lb.	lb. oz.	lb.	lb. oz.	lb.	b. oz.	lb. oz.	lb. oz.	lb.
20th March, 1930	110 0	4·469	27th March, 1930	110 12	4·536	27th March, 1930	117 0	4·902	20th March, 1930	116 4	4·897	227 0	9·371	227 0	9·433	113 8	4·686	113 8	4·717
21st March, 1930	109 0	4·702	28th March, 1930	108 8	4·471	28th March, 1930	115 8	4·810	21st March, 1930	117 8	4·791	224 8	9·512	226 0	9·262	112 4	4·756	113 0	4·631
22nd March, 1930	111 8	4·585	29th March, 1930	112 12	4·715	29th March, 1930	118 0	4·955	22nd March, 1930	117 0	4·888	229 8	9·540	229 12	9·603	114 12	4·770	114 14	4·802
23rd March, 1930	109 8	4·544	30th March, 1930	107 4	4·593	30th March, 1930	114 0	4·779	23rd March, 1930	111 8	4·595	223 8	9·323	218 12	9·188	111 12	4·662	109 6	4·594
24th March, 1930	110 0	4·700	31st March, 1930	107 8	4·543	31st March, 1930	114 8	4·857	24th March, 1930	115 0	4·932	224 8	9·617	222 8	9·475	112 4	4·808	111 4	4·738
25th March, 1930	107 8	4·493	1st April, 1930	104 4	4·231	1st April, 1930	116 8	51·32	25th March, 1930	116 4	4·882	224 0	9·625	220 8	9·113	112 0	4·813	110 4	4·557
Total	657 8	27·553	Total	651 0	27·089	Total	695 8	29·435	Total	693 8	28·985	1353 0	56·988	1344 8	56·074	676 8	28·496	672 4	28·039
Average	109 8	4·592	Average	108 8	4·515	Average	115 15	4·906	Average	115 9	4·831	225 8	9·498	224 1	9·346	112 12	4·749	112 1	4·673

NOTES OF INTEREST

TEA GROWING IN NYASALAND

MR. F. A. Stockdale, Agricultural Adviser to the Secretary of State for the Colonies, said while recently in Nyasaland that he favoured the establishment of a small agricultural research station in Mlanje, for the purpose of investigating soils and the methods of tea cultivation, especially shade and pruning. Cultural conditions in that district struck him as approximating more closely to those obtaining in parts of Assam than in Ceylon; he commented on the general absence of shade trees. Mr. A. E. Shinn, the well-known local planter, said that there are now about 8,000 acres under tea in Mlanje and a further 2,000 in Cholo.—*East Africa*, Vol. 7, No. 331, January 22, 1931.

TEA

THE tea shrub is *Camellia Thea* Link., a native of Upper Assam, Cachar and China, and cultivated in other parts of the world. The first mention of tea is in a Chinese annal dated A.D. 793. Europeans do not appear to have acquired any knowledge of tea until the latter half of the sixteenth century. Russia first obtained tea in 1638, through the envoy to the Mongol Emperor, who received several packets overland as a tribute to the Czar. This soon found favour with the Court of Moscow and became a national beverage. It was also conveyed to Europe by the Dutch East India Company and was probably introduced into England through the Portuguese before the year 1657. The English East India Company took steps to secure regular supplies, as in 1677 tea was an expensive luxury, being sold in London for £5 to £10 a pound. During the eighteenth century tea was imported from China in increasing quantities under the control of the East India Company. For the 100 years 1710-1810 the aggregate sales amounted to 750,470,016 ob., the value of which was close on £130,000,000. Difficulties having arisen with China, the British Government became interested in an effort to produce tea in India. Lord William Bentinck, encouraged by the experiments of Bruce and Scott in Assam, took up the matter of local cultivation. The first Assam tea was sent to England in 1838. In 1852 the tea industry appeared so promising that in a few years the whole of the upper portion of the Province of Assam was converted into tea plantations, and followed soon afterwards by the opening up of estates in Chittagong, Chota Nagpur and the Duars. Tea now occupies half a million acres of land in Assam, and the industry gives lucrative employment to 600,000 persons. The first exports in 1838 were 488 lb., in 1904 they stood at 200 million, valued at £6,000,000. The production of tea in the whole of India in 1924 was 375, in 1925, 364, and in 1926, 392 million pounds. Assam contributed 62 per cent., North India (excluding Assam) 25 per cent., and South India 13 per cent. More than 84 per cent. is shipped to the United Kingdom. India and Ceylon are therefore giving to England a regular supply of a much purer and an infinitely cheaper article than it formerly received from China.—*The Chemist and Druggist*, Vol. CXIV, No. 2659, January 24, 1931.

TUNG OIL PRODUCTION IN FLORIDA

A NEW industry has lately sprung up in Florida, United States, namely, the growing of Tung trees for oil, for which the climate is excellently adapted. The Tung tree (*Aleurites Fordii*) is normally found growing wild on hillsides and rough slopes, without cultivation or attention. Experience in Florida has shown that the tree will grow successfully on any type of soil that is well-drained, free from limestone, and possessing a slightly acid reaction. The tap-root penetrates to a depth of six or seven feet and it is important that the level of the underlying water table be below that depth. The trees will not succeed on wet land. Large areas of high Pine lands in central Florida are found to be ideally adapted to the production of Tung oil, and extensive tracts of that type will undoubtedly, within the next few years, be planted with Tung trees. Tung trees were introduced into Florida from China about twenty years ago. The Chinese employ the oil in waterproofing their clothes, boots, junks and residences. The American industrial chemist bas expanded the utility of Tung oil in more than a hundred every-day uses. In the manufacture of paints and varnishes it has been found far superior to Linseed oil; it has extended to the peparation of enamels and lacquers, metal and cement dressings, insulating compounds, auto-brake linings, oilcloth, linoleums, and even dress materials, which latter are composed in beautiful texture and patterns from a combination of cellular material and Tung oil. So far, there are only a few thousands acres of Tung trees in Florida, but it is anticipated that about 10,000 acres will shortly be planted and as it is estimated that 400,000 to 500,000 acres in bearing will be necessary to supply the present demand, it is evident that the question of overplanting need not concern the grower for another decade.—*The Gardeners' Chronicle,* Vol. 89, No. 2300, January 24, 1931.

INTERESTING RUBBER FIGURES

IT is not generally known that the pre-war consumption of raw rubber was greater in Europe than in the U.S.A.

The figures are illuminating, because immediately the war broke out America began to go ahead for perfectly obvious reasons. The following are the figures for the 4 years pre-war in tons:

	United States	Europe
1910	42,254	54,857
1911	41,901	54,026
1912	55,979	60,916
1913	52,028	73,522

It will be seen that Europe was going ahead very fast and, no doubt, would have continued to do so only for the Great War. However, everything now points to the balance of the rubber trade gradually swinging in Europe's favour again.

Last year America imported 528,608 tons of raw rubber as against 296,773 tons for Europe, which, of course, includes the United Kingdom.

The population of Europe is capable of consuming much greater quantities than it is now doing and everything points to progressive increase in consumption from this quarter for many years to come.

Another interesting point is that "other countries" than those mentioned, which in 1930 took only 1,980 tons of rubber, imported 51,757 tons in 1929.

Most of this increase is attributable to Japan, which country is fast becoming an important factor in the rubber goods manufacturing world. She has a vast potential market at her doors and should be given every encouragement to develop this market.—*The Malayan Tin and Rubber Journal,* Vol. XX, No. 2, January 31, 1931.

MEETINGS, CONFERENCES, ETC.

RUBBER RESEARCH SCHEME (CEYLON)

***Draft Minutes of a meeting of the Board of Management, held at the* Grand Oriental Hotel, Colombo, on Friday, December 5, 1930, at 9 a.m.**

Present.—The Hon'ble Dr. W. Youngman, Director of Agriculture, (in the chair), the Assistant Colonial Treasurer, Messrs. A. S. Collett, A. E. de Silva, B. F. de Silva, C. E. A. Dias, J. Farley Elford, the Hon'ble Mr. C. H. Z. Fernando, the Hon'ble Mr. H. R. Freeman, the Hon'ble Mr. C. E. Hawes, Messrs. J. D. Hoare, J. A. D. Finch Noyes, C. A. Perera, D. C. Senanayake, Colonel T. Y. Wright, Mr. J. I. Gnanamuttu, (*Secretary*).

Apologies for absence were received from Mr. F. H. Griffith and the Hon'ble Mr. A. F. Molamure.

Mr. T. E. H. O'Brien, Chief Technical Officer, was present by invitation.

1. CONSTITUTION OF NEW BOARD OF MANAGEMENT

The Chairman stated that the nominations to the Board of Management of the gentlemen named below had been published in a Government *communiqué*, and he was glad that their first meeting was so well attended:

The Director of Agriculture (*Chairman*)
The Assistant Colonial Treasurer

Unofficial Members of the Legislative Council, nominated by His Excellency the Governor:

The Hon'ble Mr. C. E. Hawes
The Hon'ble Mr. H. R. Freeman
The Hon'ble Mr. A. F. Molamure

Nominated by the Ceylon Estates Proprietary Association:

Colonel T. Y. Wright
Mr. J. A. D. Finch Noyes

Nominated by the Planters' Association of Ceylon:

Mr. J. Farley Elford
Mr. F. H. Griffith

Nominated by the Rubber Growers' Association (Incorporated):

Mr. A. S. Collett
Mr. J. D. Hoare

Nominated by the Low-country Products Association:

The Hon'ble Mr. C. H. Z. Fernando
Mr. C. E. A. Dias
Mr. D. C. Senanayake
Mr. A. E. de Silva

Nominated by His Excellency the Governor to represent small-holders:

Mr. C. A. Perera
Mr. B. F. de Silva

2. MINUTES

(a). The minutes of the final meeting of the Executive Committee of the old Rubber Research Scheme had been circulated to the members of the new Board.

(b). The Chairman stated that he was given discretion, in respect of the minutes of meetings of the Board of Management of the Coconut Research Scheme, to omit or vary the official record before their publication in the Press, but of course the full minutes of proceedings would be available to members of the Board. Mr. Finch Noyes moved, and Colonel Wright seconded, that the Chairman be authorised to follow the same procedure as that of the Coconut Research Scheme. Mr. Dias enquired whether members were not at liberty to consult the Associations which they represented. Mr. Bickmore pointed out that certain questions might arise which it would not be desirable to discuss outside the Board and that accredited representatives of Associations should be trusted to take responsibility for their action. Mr. Finch Noyes said that, in his own case, he consulted his Association in regard to particular points on the agenda. Colonel Wright added that a *résumé* of the proceedings of Board meetings was expected by the Associations from their representatives. It was generally agreed that a hard and fast rule about consultation with Associations could not be laid down. Colonel Wright suggested that confidential records might be entered and circulated as such on a separate sheet of minutes. It was finally decided that an expression of opinion should be recorded at each meeting what, if any, matter should be kept confidential. It was also agreed that publication of the minutes in the Press be made within two weeks of a meeting.

3. CONTINUANCE OF THE WORK AND STAFF IN LONDON

(a). With reference to the correspondence and memoranda which had been circulated to the members, the Chairman submitted that an abrupt termination of the work in London would be detrimental to the industry and recommended that the London organization should be continued. Mr. Bickmore added that the usefulness of the work in London had been acknowledged by the technical staff. In reply to Mr. Dias, Mr. O'Brien stated that the rubber industry of Java had an organization in Holland. The Chairman was of opinion that in the past Ceylon had had a return for the money expended in London. In reply to a query whether it was not possible to confine the work to Ceylon, the Chairman pointed out that it was necessary to have an organization where their market was. Mr. Bickmore added that Ceylon should have a body to whom technical problems could be referred and by whom the requirements of manufacturers could be studied. It was understood that the reason why Malaya had not done any work in London up to now was that their institution started only three years ago.

Mr. Freeman moved that the London staff and research work be continued on the present footing for 1931. This was seconded by Mr. Dias, supported by Mr. Hoare, and carried unanimously.

(b). The scheme of amalgamation of the research work in London with that of Malaya, as set forth in the London Secretary's letter of 7th July, 1930, which had been circulated to members, was deferred for further consideration, the Chairman pointing out that the London Advisory Committee was submitting some points for consideration. Mr. Dias submitted that the proportion of 30% (£1,500) of the estimated initial annual expenditure of £5,000, which had been suggested for Ceylon, called for comment in view of the fact that the ratio of exports of rubber from Ceylon and Malaya was 18 to 82 and that of the acreage was 20 to 80.

4. TRANSFER OF ASSETS, LIABILITIES AND STAFF OF THE OLD SCHEME

The Chairman mentioned that the Executive Committee at their last meeting had discussed the question of handing over to the new Board and had resolved unanimously that the entire assets, liabilities and staff of the old Rubber Research Scheme be offered to the Board of Management of the new Rubber Research Scheme, with effect from August 1, 1930, the date on

which the Rubber Research Ordinance came into operation. This offer was subject to confirmation by a meeting of subscribers to the erstwhile Scheme. Mr. Bickmore stressed the advisability of taking over the capital of the Scheme and building upon it; the alternative to taking over would be to disband all work and staff for at least one year. The Chairman added that the cash balance of the old Committee would be exhausted by the end of December. The assets consisted of land acquired, buildings, water supply, laboratory apparatus, furniture, fittings and office equipment, the London plant, and investment on the Experiment Station, Nivitigalkele, making a total roughly of Rs. 137,000. The question of leases that the old Committee had entered into would have to receive attention.

Mr. Freeman moved that the assets, liabilities and staff of the old Rubber Research Scheme be taken over by the Board of Management. Colonel Wright seconded. This was carried unanimously.

(b). The Cairman stated that the Colonial Auditor would audit the accounts as from August 1, 1930. It was decided that no action was called for in regard to audit fee.

The Chairman regretted that he had to attend a meeting of the Finance Committee of the Legislative Council with regard to a matter that could not be postponed, at 10 a.m., and suggested that Mr. Bickmore be acting Chairman during his absence. This was proposed by Mr. Finch Noyes and seconded by Mr. Collett. Mr. Bickmore took the chair.

5. CHEMIST AND CHIEF TECHNICAL OFFICER

A decision as to the terms of re-engagement of Mr. T. E. H. O'Brien was thought desirable before the draft estimates for 1931 were taken up. It was proposed by Mr. Dias, seconded by Mr. Senanayake, and carried unanimously, that Mr. O'Brien's services should be retained on terms which would be no worse than under his present agreement, with the continuance of the allowance paid to him as Chief Technical Officer. Mr. O'Brien was then asked as to his intentions about home leave. Mr. O'Brien thought it would not be in the interests of the Research Scheme that he should take leave before further staff had been appointed. He wished to do what was best for the Scheme and would be willing to postpone his leave. The terms offered for the continuance of Mr. O'Brien's services were explained to him and accepted.

6. DRAFT ESTIMATES OF INCOME AND EXPENDITURE FOR 1931

Rubber Restriction Fund

The acting Chairman explained that alternative estimates had been circulated on the footing: (a) of the Cess collections only accruing as revenue, and omitting provision for work in London, and (b) of the Rubber Restriction Fund being made available and a full programme of work being undertaken. He was of opinion that the Rubber Restriction Fund should be regarded as a capital sum available for the purchase of an estate or the development of an estate from jungle. He added that the sum of Rs. 100,000 reserved out of the Restriction Fund was against the possibility of restriction being reintroduced and that the entire fund might be released, if need be under an amending ordinance. It was necessary to decide whether the Board should ask Government for any part of the Rubber Restriction Fund for the purposes of the rubber industry. Mr. Dias' view was accepted that the surplus money in the Rubber Restriction Fund should be utilised only for capital expenditure and that application for this money should not be made until a scheme of capital expenditure was drawn up. Mr. Finch Noyes proposed, Mr. Collett seconded, and it was carried unanimously, that the Rubber Restriction Fund be not taken into consideration in framing the estimates for 1931.

Income

The acting Chairman thought that the estimate of Rs. 120,000 under Cess collections was too conservative. Mr. Collett suggested that a revenue of Rs. 150,000, based on exports approximating 70 per cent. of those of the current year, would be reasonable. It was agreed that Rs. 150,000 should be substituted for Rs. 120,000. Mr. Collett further suggested that the sum of Rs. 100,000 accruing (for the five months) up to December 1930 be reserved as a working capital. This was agreed to.

Personal Emoluments

Mr. Dias urged that the point should be decided whether future salaries to the superior staff should be paid on a sterling or a rupee scale. Mr. Senanayake proposed that a rupee scale should be adopted. The acting Chairman suggested that the adoption of a rupee scale should await a similar course in the public services generally. It was decided that the matter should receive consideration in 1931.

Dr. Youngman resumed the chair at 10-45 a.m.

Item No. 1. Director of Research.—With reference to the scale of pay for a Director of Research, the Chairman mentioned that the Rubber Research Institute of Malaya advertised in July last for a Director at a salary of £2,520-£140-£2,800 per annum. He suggested that it would be wisdom to employ the best possible man they could obtain and be prepared to pay a salary commensurate with his reputation and qualifications. The London Advisory Committee, he said, were willing to help in making appointments. Mr. Dias thought they should not hesitate to advertise their requirements in Java and America as well as elsewhere. Mr. Freeman suggested that the post should be made well-known and that all applications should come before the Scheme in the first case so that the Scheme could see who was available.

Mr. Dias proposed and Mr. B. F. de Silva seconded that the Chairman be authorised to advertise with a view to securing the best man available and that the salary be left open. This was agreed to, and the salary of Rs. 18,000 included in the draft estimates was passed as a provisional vote.

Item No. 3. Physiological Botanist.—It was decided that the provision of Rs. 4,500 for salary for six months should remain, but that a selection for the post be made after the appointment of the Director of Research.

Item No. 5. Geneticist.—Mr. Dias urged the need for the immediate appointment of a Geneticist. The Chairman explained that the type of man required both for this post and that of Physiological Botanist might in a way depend upon the future Director. If the Director, for instance, were a Geneticist his advice would be of value in connection with the matter.

After further discussion, Mr. Finch Noyes moved that the posts of Director of Research, Physiological Botanist and Geneticist be all advertised and that applicants be invited to state the salary required. This procedure was approved. Mr. B. F. de Silva suggested that the applications should be addressed to the Chairman of the Board and that any further steps to be taken be considered by the Board after the receipt of the applications. This view was supported by Mr. Dias and was accepted. It was desired that the Chairman might consult Dr. P. J. S. Cramer, formerly Director of the Experimental Station, Buitenzorg, Java, who was at the time in Colombo, upon the subject of securing a Director of Research.

Item No. 17. Bonus to Subordinate Staff.—It was decided to delete the provision of Rs. 458 from the 1931 estimates in view of the financial depression. The payment of the usual bonus for the current year was sanctioned.

Item No. 9. Budding Instructor.—Mr. Dias urged the necessity of having a really good expert man for budding work at the Experimental Station. Such a man, he said, should be able to show 80% successes in budding. The provision of Rs. 720 was increased to Rs. 840, the commencing salary of an Agricultural Instructor (probationer's grade.)

The total sum voted under the head Personal Emoluments amounted to Rs. 67,673.

Other Charges

Mr. Dias suggested that a scheme of development should be determined that day. The Chairman said that, necessary as he thought it was actively to embark upon a policy of development, he also thought there was great wisdom in first appointing a Director of Research. This view was supported by Mr. Finch Noyes and was endorsed by the Board.

Item No. 22. Travelling.—The Board approved of the payment of an inclusive motor car mileage of 25 cents for attendance at meetings, after the practice of the Coconut Research Scheme.

Special Expenditure

Item No. 24. London Advisory Committee Expenditure.—The London Advisory Committee's application for £2,605 to meet their normal expenditure in 1931 was accepted and this item was included in the estimates.

Item No. 25. Sinking Fund for Bonuses and Passages.—At Mr. Bickmore's suggestion the provision under Bonus and Passage Fund was increased from Rs. 6,300 to Rs. 10,000.

Item No. 23. Experiment Station.—Mr. Dias enquired whether the rubber research work at Iriyagama was to be continued by the Department of Agriculture or handed over to the Rubber Research Scheme. The Chairman replied that the experiments in hand would be continued and completed by the Department in 1933. He added, in reply to Mr. Freeman, that Government had been anxious to make a start at a time when the future of the Rubber Research Scheme was in a nebulous state. The lines of work proposed in connection with seed gardens and budwood nurseries remained to be undertaken and the Board might consider taking over this part of the programme under the Rubber Restriction Fund, after the arrival of the new staff.

The total sum voted under the head Other Charges, including Special Charges, amounted to Rs. 87,217.

6. STAFF

The Chairman invited consideration of an applictaion from a laboratory assistant for the payment of fees for medical attendance on his wife. Mr. Finch Noyes stated that on the estates every such case was considered on its merits. It was decided that the present case did not appear to call for special consideration and could not be entertained.

7. EXPERIMENT STATION

(a). *Drainage of Budwood Nursery.*—After discussion, the Board considered it inadvisable to proceed at present with the suggested scheme of drainage.

(b). The Chairman suggested that a scheme of manurial experiments submitted by Mr. Taylor and some correspondence thereupon might not be pursued for the present. This was approved.

(c). Mr. Farley Elford proposed and Mr. Senanayake seconded that a Visiting Agent be not employed. At the instance of Mr. Dias, it was agreed that, should the position of a Director of Research remain long in abeyance, this might be again considered at a later date.

(d). The Chairman referred to a letter from Mr. Dias calling for information relating to the work at Nivitigalkele. A written statement prepared by Mr. O'Brien and supplying the information so far as possible was tabled. It was considered desirable that similar information required by any member of the Board should be supplied by the research staff at the discretion of the Chairman; any matter of a confidential nature to be stamped as confidential and treated as such.

8. TECHNICAL REPORTS

The progress reports of the Chemist, the Mycologist and the Agricultural Assistant for October 1930, copies of which had been circulated, were passed without comments.

Mr. Bickmore raised the question of appointing a Technical Committee to come to decisions upon technical matters. The Chairman suggested that such a Committee had not proved altogether suitable in the past and that the Director of Research or the Chief Technical Officer could always receive advice upon any point from the scientific staff at Peradeniya. Mr. Dias supported this method rather than the appointment of a Technical Committee, and it was accepted by the Board as the best course to adopt.

9. PUBLICATIONS

(a). The publication of Mr. Murray's booklet on Diseases of Rubber, in the same way as the booklets prepared by Messrs. O'Brien and Taylor, was sanctioned.

(b). Correspondence with the Rubber Growers' Association and the Rubber Research Institute of Malaya regarding exchange of publications was considered. The matter was left over for further consideration after the Rubber Growers' Association had stated the minimum number of copies they required of the bulletins, leaflets and circulars of the Scheme.

(c). The question as to what persons were eligible for the free supply of the Scheme's publications was also noted for further consideration. Mr. Bickmore urged the necessity of circulating the results of all research work.

(d). With reference to the London Advisory Committee's minutes of October 24, 1930, and their complaint that they had not sufficient information of activities in Ceylon, the Chairman thought that *The Tropical Agriculturist* should be subscribed for by the people in London who were interested in Ceylon. With reference to their suggestion that the decision not to reprint Mr. L. Lord's report upon his visit to Java, Sumatra and Malaya, be reconsidered, the Chairman was authorised to order a reprint if and to such extent as the balance of funds of the old Rubber Research Scheme could meet the cost.

10. FUTURE MEETINGS

It was resolved that a meeting of the Board should be held every other month and that the third Thursday of the month should be adhered to as far as possible. It was agreed that notices of motions be sent to the Secretary fifteen days before the date of a meeting. Mr. Freeman desired that a further effort should be made to obtain a Committee room of the Legislative Council for the meetings of the Board.

By order,
JOS. I. GNANAMUTTU,
Secretary,
Board of Management,
Rubber Research Scheme, (Ceylon).

Peradeniya, 8th December, 1930.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28th FEBRUARY, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	107	60	19	74	12	2
	Foot-and-mouth disease	49	29	24	...	25	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs).	2*	1	...	...	...	2
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	.	...	...	...	...	...
	Foot-and-mouth disease	148	92	79	4	65	...
	Anthrax	7*	6	...	7	...	...
	Rabies	2	2	...	2	...	...
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	
Cattle Quarantine Station	Rinderpest	..	...	...	...	...	...
	Foot-and-mouth disease	...	..	...	...	...	...
	Anthrax (Sheep and Goats)	54	30	...	54	...	...
Central	Rinderpest	...	..	...	...	...	...
	Foot-and-mouth disease	14	14	...	...	14	...
	Anthrax (Sheep and Goats)						
	Rabies (Dogs)	6	6	...	6	...	...
Southern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	567	424	430	2	135	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	
Northern	*Rinderpest*	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Black Quarter						
	Rabies (Dogs)						
Eastern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
North-Western	Rinderpest	2212	1097	61	1883	17	251
	Foot-and-mouth disease	...	...	...	...	..	...
	Anthrax	...	...	...	..	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	1636	651	124	1413	99	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	...	1	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	..	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	..	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
	Piroplasmosis	1	...	...	...	1	...
	Haemerrhagic Septicaemia	5	5	...	5	...	...

*1 case in a cow.

G. V. S. Office,
Colombo, 10th March, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

FEBRUARY, 1931

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo -	88·1	+1·1	73·9	+2·7	72	90	4·6	3·48	6	+ 1·41
Puttalam -	90·3	+3·5	72·1	+2·9	67	90	3·9	0·27	3	– 1·01
Mannar -	88·2	+2·2	75·2	+2·3	68	88	3·2	0.00	0	– 1·32
Jaffna -	85·5	+0·9	—	—	72	—	4.1	0·01	1	– 1·27
Trincomalee -	82·6	0	77.6	+2·9	76	80	4·4	2·53	4	+ 0·35
Batticaloa -	83·2	+0·4	75·3	+2·7	78	91	6.2	3·35	8	– 0·09
Hambantota -	86·2	+0·4	73·6	+1·5	73	90	3·8	1·51	5	+ 0·10
Galle -	87·0	+2·7	74·1	+0·8	77	90	4·8	1·39	10	– 1·55
Ratnapura -	93·1	+3·8	72·2	+0·2	64	93	4·1	3·59	13	– 0·98
A'pura -	87·4	+1·2	69·3	+0·3	67	87	4·7	0·00	0	– 1·55
Kurunegala -	90·5	+0·3	70·5	+1·6	63	90	4·3	0·21	2	– 1·52
Kandy -	86·0	+1·5	69·1	+2·6	62	85	3.4	0·85	4	– 1·40
Badulla -	78·9	–0·1	64·2	+2·1	78	97	5·2	4·19	6	+ 1·26
Diyatalawa -	76·0	+2·0	57·5	+1·4	70	91	4·6	1·15	4	– 1·17
Hakgala -	71·3	+0·4	52·5	+2·9	78	88	5·0	2·82	5	– 0·49
N'Eliya -	70·8	+1·4	45·8	+2·0	64	90	4·4	1·44	6	– 0·58

The rainfall of February was mainly in deficit, a large majority of the rain-gauge stations north of the Puttalam-Trincomalee line reporting no rain at all during the month. Excess, however, predominated in the southern half of the Eastern Province, and on the north-eastern slopes of the hills, while the Colombo district also showed a slight excess.

Falls of over 5 inches in a day were recorded at St. Martin's, (Upper 7·10 inches, Lower 5·40), Hendon, (6·72) and Viragoda (6·15).

Temperatures, both by day and by night, were in general distinctly above normal. A noteworthy example was on the 21st when Colombo's minimum temperature at night only went down to 78°F which is unusually high for this time of year. The humidity was above normal by day, while by night it was, on the whole, about normal. At the coast the amount of cloud was slightly above normal, while inland and among the hills it was slightly below. The duration of bright sunshine was distinctly above average.

The wind was dominantly NE, and above normal strength, though light enough for the effect of sea breeze to be apparent on the west coast. The barometric pressure was also above normal.

A. J. BAMFORD,
Superintendent, Observatory.

The

Tropical Agriculturist

April 1931

EDITORIAL

PRECONCEIVED NOTIONS AND THE COCONUT BEETLE

THE appearance of the swallows in England at the beginning of the spring was at one time believed by many to be the result of their awakening from a hibernating period in the woods or even from under the water in ponds. So keen a naturalist as Gilbert White records that on an occasion he had the coppices in the neighbourhood of his home beaten out to see if he could disturb such birds from their winter sleep.

A somewhat similar fallacy exists in Ceylon with regard to the coconut beetle (*Oryctes rhinoceros*). Its appearance on coconut estates is frequently being attributed to its breeding in coir refuse dumps in the neighbourhood. The example of Gilbert White's method of testing his theory is recommended to those who believe the coconut fibre dumps to be the places from which the beetles come when they appear abroad. It would be a good plan for those who have coir refuse heaps in proximity to estates where the beetle is a pest to have these heaps carefully examined for beetle larvae and pupae. Preconceived notions are always of the greatest danger to the establishment of truth. One of the earliest principles that a scientific investigator has to learn concerns the value of a preconceived notion, if it does not rigidly stand the test of the severest cross-examination, it has to be absolutely dropped and never allowed to influence the mind in arriving at a conclusion.

This preconceived notion that the coconut beetle breeds in the coir dumps has so far not been supported by unprejudiced investigation and until it is the breeding ground of the beetle must be looked for elsewhere.

From all sides come reports of an increase of this enemy and the damage done by it on coconut estates. It behoves all interested then to take every precaution to try to bring it under control. The larvae and pupae of the beetle can be found in decaying organic matter such as fronds, fallen coconut tree heads and trunks and other plant material, including dead cover crops. The transference of such substances into a fertilising agent by letting the processes of decay do their work should therefore be done under precautions that will prevent the multiplication of the beetle. Criticism of one's neighbours' fibre dumps is not such a precaution. The prevention of decaying vegetable matter from becoming beetle propagating centres is the duty of all, both upon and near coconut estates. If such material is not required the sooner it be destroyed by fire the better but on the estate itself it will be desired to transfer it into humus rather than into ashes. This should be done by entrenching it in pits sufficiently deep to allow of its being covered by about a foot of sand or soil free from humus. The covering of the material is of the greatest importance. On some estates it is the custom to simply place the rubbish in trenches and perhaps to sprinkle a fertiliser upon it. Neither of these methods without covering is sufficient. The admixture of a fertiliser with the leaf-fall gives an excellent method of improving the estate but if the material be left uncovered the fertiliser may not be a preventative of beetle multiplication. Rainfall may wash the deeaving fronds and other material free of the fertiliser and leave nothing objectionable to the beetle. The covering of the trenches with soil prevents to a large extent such action from taking place and thus leaves the material noxious to the beetle eggs and larvae. A similar precaution should also be taken with the use of green manures. If these be ploughed in with the addition of a fertiliser, it should be possible to render the soil uncongenial to the beetle.

The undesirable increase of the beetle and the necessity of taking precautions to prevent its spread are of sufficient importance to warrant serious notice and are therefore the reasons for making them the theme of this paragraph.

THE MANGO IN CEYLON

T. H. PARSONS, F. L. S., F. R. H. S.,
CURATOR, ROYAL BOTANIC GARDENS, PERADENIYA

1. CEYLON TYPES OR VARIETIES

FEW fruits, if any, have in India the reputation and history of the Mango (*Mangifera indica*) considered by De Candolle to have been in cultivation for many centuries, and certainly as far back as any dependable records go.

A native of India and the eastern tropics, its cultivation reaches to all tropical regions of the world, but the true home of the mango with its numerous varieties and hybrids is undoubtedly India.

Sturtevant in his "Notes on Edible Plants" gives Tropical Eastern Asia as the home of *Mangifera indica* and regarding the distribution of this fruit he records that the mango was introduced to Jamaica in 1782. In 1880 several fruitful and superior varieties were growing in the Botanic Gardens in Trinidad, and at Cayenne it was introduced at the beginning of the present century. Its introduction into Brazil was more ancient as the seeds came thence from Barbadoes in the middle of the eighteenth century, and in Martinique, by grafting, a dozen distinct varieties of excellent quality have been established. In Mauritius a number of varieties are established, whilst the tree is now grown to a limited extent in Florida also.

Although the fruit is found in the markets, the bazaars, and in the villages of Ceylon in large numbers during its season, the quality is invariably extremely poor and the fruits are usually from seedling trees. The few really good fruits to be found occasionally in the markets are generally those imported from India from grafted or enarched trees, but these in most instances suffer from the fact that the fruit is picked in too unripe condition and this detracts from the true flavour of a first-class mango.

There are in Ceylon about five types of the common mango. These are (i) the "Jaffna" mango which is of good quality when well grown, large, oval in shape, and not unlike the "Alphonso" of India; (ii) the "Rupee" mango, or Pol-amba a large globular-shaped fruit of good flavour, in great demand but never available in any large quantity owing to its shy fruiting habit; (iii) the "Parrot" mango or Gira-amba, a medium-sized fruit with broad marked beak and of a slightly acid but pleasant

taste; (iv) the "Bombay" mango or Baita-amba, a round and compressed fruit, juicy, yellow when ripe, of average quality and probably the commonest variety to be found in the Ceylon markets, and (v) the "Honey" mango, or Mi-amba, a somewhat small round fruit, of acid and poor flavour resembling turpentine rather than honey.

There are also wild varieties. The Etamba bearing a small oval fruit with scanty juicy pulp of a tart flavour, and though occasionally eaten, it is very unpalatable. The Puhuamba is another variety with very small fruit, acid but sweet flavour, and seedless.

The Ceylon mangoes generally leave much to be desired, yet many parts of the Island are suited to the proper cultivation of really good varieties and much more could be made of the mango than has been the case up to the present. The semi-dry regions of Ceylon and the dry regions also where irrigation is available are the areas most suited to this fruit though in certain districts of the wet zone varieties of the "Jaffna" mango have been observed to give quite useful crops. A pronounced dry season is, however, a very necessary climatic requirement and the reasons for this will be indicated later. Established fruit orchards worked on any up-to-date lines do not, as such, exist in Ceylon, except in rare instances. Individual enthusiasts have, however, of late years realised the necessity of an improvement and increase in fruit cultivation and production, and the opening up of small areas here and there is on the increase.

Of the mangoes common to Ceylon the "Rupee" and certain varieties of the "Jaffna" only are worth persevering with. The "Rupee" is a very fine fruit both for size and flavour, and careful experiments are necessary to ascertain if its shyness in fruiting cannot be improved by a selection of the best and the highest yielders. Its transfer by budding or enarching to a suitable stock, as European horticulturalists have similarly improved the temperate region fruits, wants to be tried.

2. INDIAN TYPES OR VARIETIES

The Indian mangoes are generally considered to belong to one species, *Mangifera indica*, though other species have doubtless entered largely into the composition of most of the cultivated forms. The number of types, sub-types, varieties, and sub-varieties are legion and present the problem of a cross-word puzzle. Indian nurserymen have undoubtedly a penchant for creating a bewildering number of new varieties from any tree that yields a fruit of superior quality, and this has led to synonymy and confusion.

The numerous requests for information on fruit growing received at Peradeniya are invariably preceded by the query as to what are the best imported varieties or types of particular fruit trees to grow. At the outset the first question to decide is whether a sufficiently good type of tree is available locally from which to propagate, or whether to import the trees required.

There must at the present time be a considerable number of imported grafted trees of good type in the Island. Many were imported in past years through the assistance of the Ceylon Agricultural Society, and of later years through the Central Seed Store, Peradeniya.

The varieties available from India on import are numerous but unfortunately a large number are worthless. Indiscriminate importations are to be avoided and plants of known good variety only should be secured. The following may be recommended:

(a) "Alphonso."—This is the leading variety of a group that keeps well and is probably the most widely cultivated mango in the Bombay Presidency. It bears fruit of average size and excellent flavour, the skin is thin and the pulp is reddish in the middle to pale-yellow on the outside, and the average weight is 14 oz.

(b) "Bangaloora."—A long-fruited variety and above the average in size, slightly tinged with red at the extremeties, the flesh reddish, very sweet and of good flavour. At Heneratgoda Gardens a five-year-old tree of this variety produced a fruit weighing 28½ oz.

(c) "Batli" or "Batlee."—A variety common in Bombay where they come into the markets from middle of May till end of June. It is a heavy, luscious fruit, with deep orange flesh, and the fruits average 14 oz.

(d) "Dilpasand".—A Bombay variety of good size fruit often 20 to 22 oz. in weight. The flesh is canary yellow, fibreless, with thick pulp and a flavour slightly acid, but delicious. This should not be confused with the South Indian "Dilpasand," as the latter is not so delicately flavoured and resembles more the "Totipuri" than the round "Dilpasand" type.

(e) "Fernandin."—A highly-prized variety with thin skin and flesh of bright yellow and thick consistency. A very superior fruit averaging 16 oz. but often 20 oz. or more in weight.

(f) "Koothathath."—A variety very similar to "Bangaloora" but with greenish colouring, yellow when ripening. Fruits are large, averaging 18 oz. each, the flesh being light in colour, fibreless, and of good taste and flavour.

(g) "Mulgoa."—A very fine mango of the Madras type and grown in abundance in Bangalore. In America this variety, the first of the Indian grafted trees to fruit there, does not fruit freely, but in the eastern tropics little fault can be found as to its fruit-yielding capacity and both in appearance and taste the fruit is exceptionally good. The skin is thin, the pulp pale-yellow, and the average weight of the fruit about 16 oz.

(h) "Piari."—This variety is of the type considered by many to produce the finest mango in India, but it is of rather poor keeping quality. The skin is moderately thick, the flesh bright yellow to orange, of fine texture, firm and juicy and of excellent flavour. The average weight of the fruit is 14 oz.

(i) "Peter Pasand."—A fruit of average size and of excellent taste and flavour. The skin is thin and separates easily from the pulp. Though not so well known as the foregoing varieties, can be well recommended, the fruits averaging 14 oz.

There are of course numerous others but those described are the better known of the Indian varieties. The western tropics and other parts also have their particular varieties or types, the more prominent of these being "Julie," "Peters," and "Pere Louis" of the West Indies, not omitting the famous No. 11 of Jamaica, and the equally famous "Sundersha" of Florida, the "Caraboa" and "Pica" of the Philippines and the "Gundoo" and "Sabre" among others of South Africa.

3. SOILS

The mango as with most other fruits thrives best in a good loamy soil but it is adaptable to a wider range of soils than many fruit trees. An essential requirement is that the soil should be well drained. The laterite and cabooky soils of many parts of Ceylon are suitable, though a good loamy soil is best since this produces and supports good yields and excellence of fruit. The red laterite soil of parts of India is well known to be most suited to mangoes. A shallow soil of hard rock or pure sand is not a suitable one since the mango is a deep-rooted tree, but a sandy to sandy loam soil with some depth will give excellent results provided fertilisers are applied fairly liberally and such soils in Southern Florida have proved most satisfactory. A clayey soil, provided it is well drained, seems to be a good soil for mangoes also, but the main requirements are obviously depth of soil and good drainage. The fine avenue of mango trees at the Botanic Gardens of Rio de Janeiro are of large dimensions and of great age but according to Dr. Willis, (formerly Director of these gardens, and at one time Director of the gardens at Peradeniya) these never mature any fruits owing to the original error of planting the trees on low wet ground, though others planted on higher ground in the same gardens fruit freely and regularly. Good drainage cannot therefore be too strongly emphasized.

4. CLIMATE

Most tropical areas are suitable for the mango tree and in Ceylon it will thrive from sea level to 2,000 feet and will grow, but is scarcely fruitful, at elevations up to 4,000 feet. Though the tree grows well in humid localities subject to rain at all seasons, it cannot ordinarily be successfully fruited in such since a pronounced spell at time of flowering and setting of fruit is essential.

Localities with an annual precipitation of 50 inches, or more if it does not coincide with the flowering season, are conducive to satisfactory results, and where irrigation facilities are available it will succeed with less rainfall than this. The mango is in fact better suited to irrigated areas than otherwise since its moisture requirements are peculiar in that the effect of rain or even humid atmospheric conditions at time of flowering and setting of fruit are specially injurious by its interference with pollination. The commonest cause of crop failure at Peradeniya and in other moist regions is generally considered to be due to wet or damp weather at time of flowering. In irrigated areas the trees need to be irrigated till their fourth year, but after the fourth year watering is not necessary unless the tree actually shows signs of wilting.

5. PROPAGATION

The predominant method of propagation of this fruit at the present time in India is by enarching, but propagation by means of budding is also adopted, and in the western tropics by seed-sowing also. Propagation by cuttings has not been successful to any degree. With regard to the seed it should be noted that there are two types, firstly, the mono-embryonic type with seed containing only one embryo which is produced by a sexual process and is not therefore to be depended on to produce true progeny unless it came from a true bred parent stock which is usually not the case. The second type is poly-embryonic which contain several embryos arising as buds from the outer covering of the seed and are in consequence the equivalent of a bud or a graft of the parent and therefore represent that type.

The latter type of seed is more frequently found in the western than in the eastern tropics. In the eastern tropics the first type predominates.

The systems of enarching and budding are well known to insure uniformity of fruit, early bearing, and productiveness in the majority of fruit trees, and it applies to the mango also. For this reason these methods of vegetative reproduction are advocated for growers in Ceylon, and the question of a suitable stock or stocks have to be considered. At the present moment little or no definite information is available and propagation in

the east has been almost entirely restricted to enarching. The common mango (*Mangifera indica*) the Amba, and the Ceylon wild mango (*Mangifera zeylanica*) Etamba, would as far as present experiences go, meet the case. The former is cultivated in most parts of the Island and has a wide range of climate and elevation, being suited to both dry and wet zones and to an elevation of 4,000 ft. The latter is a very large tree of robust habit found in the low-country forests of both moist and dry regions.

Little can be said at the moment as to the probable influence of stock on scion, as very few reliable trials have been made either in India or elsewhere, but it is stated that the position of the scion on the stock influences the vigour of the vegetative growth of the scion and the age at which it flowers.

The Agricultural and Co-operative Gazette, Nagpur, Vol. IX, states that Bombay grafts were seriously affected by frost each year when growing at Pagara but when such were grafted on the wild Pachmari seedlings common to the Pachmari hills the resulting trees, without deterioration of quality, were quite frost resistant.

Both statements indicate a definite physiological influence of stock on scion and the qualities of the local and the wild mango as suitable stocks in respect to their root system and other probable advantages might be taken for granted at the present stage.

The enarching mode of propagation is the most common one employed for mangoes but unless grafting material is plentiful the method is an expensive one. Patch or shield budding on the other hand conserves material to a large degree and though more difficult, is successful if properly carried out, and it is preferable generally.

In the raising of stock plants, seeds should be selected from sound healthy and vigorous trees. The seeds germinate readily when fresh but lose their vitality if kept for long and should therefore be sown at once. The seeds should be planted at a depth of three to four inches and eight to ten inches apart if the seedlings are to be lifted into pots before budding, but sixteen to eighteen inches apart if budding is to be done in the nursery bed. A difficulty is invariably experienced in lifting the larger seedlings for potting purposes owing to the tap root system of the mango but this can be remedied to some extent by making the seed-beds on shallow soil or on a foundation of brick material.

Seedlings should be ready for budding when they attain the diameter of half an inch at a few inches above the ground, but larger seedlings if available are preferable. The best time for budding is usually towards the end of the monsoons but they can

be budded at other times also, according to the receptive condition of the stock, that is, when the bark lifts easily, usually during the periodical flushes of growth which last for several weeks, and patch budding, either by the square or rectangular patch is recommended.

The actual operation of patch budding might here be described and is as follows: Assuming the bark of both stock and scion lifts easily, a square or rectangular piece of bark bearing a bud from the scion should be taken out, of approximately 1 inch long by $\frac{3}{4}$ inch wide, and transferred into the stem of the stock from which a similarly shaped piece of bark has been removed. A small quantity of grafting wax is then smeared over the edges of contact and the bud with its shield firmly tied with budding tape or strands of bark. The stock should be budded at six inches from the ground, but this can be varied according to requirements and the size of the stock. All cuts should be clean ones and the operation carried out as quickly as possible so as to prevent the cambium surfaces of the stock and scion being damaged or dried by exposure. During the operation shady conditions are preferable and, if in the open, temporary shade should be afforded till such time as the buddings are well established.

A good grafting wax is made of a mixture of beeswax 2 parts, tallow 1 part, and resin 1 part. The two former should be melted, adding the resin in a well-powdered state and the whole stirred well. Ordinary white cotton cloth serves the purpose of a good budding tape and can be cut into various lengths and widths according to the size of the stock budded, and for average-sized stocks, strips 15 inches long and 1 inch wide are the best. Soak the budding tape in the grafting wax while it is hot and hang up to dry for an hour or so, afterwards winding the tape or cloth around a stick. The waxed tape will thus keep of suitable consistency for a long time.

After 14 to 18 days from budding the bandages should be removed and if the operation has been a successful one the bud sheath will show a healthy green appearance similar to that at the time of budding. The stock should then be notched at a point five or six inches above the point of the budding to arrest the flow of sap to the head of the stock and the bandages re-tied very lightly, but on this occasion, leaving the dormant bud exposed. The budding tapes should be finally removed when the bud begins to grow, a period that can vary from four to ten weeks from budding. At this time the head of the stock can be cut off at the point previously notched to allow all the vigour of the stock plant being forced into the newly-attached bud.

Budwood should naturally be selected from healthy vigorous trees and of the best fruiting qualities available. The bud selected should be from wood of the second or third flush below the growing point and the precaution should be taken, should the leaves not have fallen, of pinching off the leaf blades some two or three weeks beforehand from the shoots required for budding, this allows the leaf-stalks to drop and leaf-scars to heal over before the wood is required for budding.

6. CULTIVATION

Soil and climatic conditions have already been discussed and having selected a suitable site, good holes at least 3 feet in width and 3 feet in depth should be prepared. The holes should be 30 feet apart each way. A good dressing of well-decayed cattle manure should be incorporated with the soil when refilling the holes.

The mangoes must be considered the main crop of the plantation, though interplanting with catch crops for the first three or four years can be entertained.

The plants will require shading and watering for the first few weeks and permanent staking is required to prevent damage by wind. Attention during the first three or four years should be devoted to the encouragement of good healthy growth with a strong robust framework. A periodical dressing of well-decayed cattle manure on the approach of the monsoons, with a forking up of bed surface and a mulch of leaves, grass cuttings or other material just prior to the dry seasons will materially assist in this. From the fifth year onward the object is to induce fruiting and a change of manure is required, since cattle manure is not generally considered an entirely suitable manure at the flowering and fruiting stage. Heavy dressings of cattle manure upset the process of normal formation of flowers, and fruit production is postponed. Manuring therefore should be much lighter at this stage and the phosphoric acid contents of such manures as are given should be increased. A useful manure mixture for trees at the flowering and fruiting stage is recommended by the Acting Government Chemist, Peradeniya, as follows:

Sulphate of Ammonia	½ part	5-6 lb. per tree
Superphosphate	2 parts	
Steamed Bonemeal	2 ,,	
Sulphate of Potash	2 ,,	

in addition to small dressings of cattle manure or leafmould.

7. PRUNING AND THINNING

The fruit-bearing qualities of the mango vary greatly and much is doubtless involved in the principles of pruning or thinning adopted. These have not yet been worked out with any

accuracy. Unfavourable weather conditions in the direction of heavy rains, cold conditions, and even excessive heat if accompanied by hot dry winds at time of flowering are seriously adverse to the tree. Overbearing and exhaustion following a heavy crop are other difficulties to contend with, but these can be prevented or modified to some degree by the thinning of the crop in the early stages, and subsequent thinning out of the growing shoots. The mango is, like certain other fruit trees, subject to the peculiarity of alternating fruit years and prevention of overbearing from the early years can assist in overcoming this disadvantage.

According to investigations to date unfruitfulness in the mango is not due to defective mechanism of pollination. Popenoe, in a very thorough study of the subject of the pollination of the mango, concludes that mango sterility is due to climatic conditions which appear to favour vegetative growth and not reproductive growth. Root pruning can usefully be employed on unproductive trees, such operations tending to the formation of fruit buds which require to be encouraged by some check to the vigour of the tree.

Speaking generally, pruning, thinning, or root pruning, whichever is applied, means the checking or suppression of certain parts of the tree, either vegetative growth or root growth, in order that additional energy may be directed towards building up the tree structure, or when growing too freely to flower or fruit well. The reduction of vigour by restriction of root supply, usually by means of root pruning, induces profusion of flowers and consequently the larger possibility of yield of fruit.

8. PESTS AND DISEASES

Of the insect pests common to the mango the Government Entomologist has afforded the following information in respect to the chief of its enemies:

Fruit pests.—The most important insect pests of mango fruits are the mango seed weevil (*Cryptorhynchus mangiferae*) and fruit flies (*Dacus* spp.).

1. The seed weevil is found in most parts of the world where mangoes are grown. The weevil lays its eggs in the fleshy portion of the young fruit and the grub on hatching bores into the seed and passes the remainder of its life inside the seed where it changes into the pupa and finally into the weevil. Portions of the pulp may become rotten, and infested fruits may drop prematurely. The presence of more than one grub in a young seed may result in its entire destruction, but usually the seed is not injured seriously enough to prevent germination. The weevils may remain in the seed until after the fruit has been

eaten and the seed has been discarded. Since this pest passes the whole of its early life inside the seed and there is often no external evidence of injury there is no practicable method of control except the collection and destruction of all fallen fruit.

2. Fruit flies are occasionally serious pests. The eggs are laid in the fruit and the maggots after destroying the fruit emerge to pupate in the soil. Poisoned baits can be used to attract and kill the flies before they lay their eggs. The usual bait recommended is a mixture of 6 lb. of cheap sugar and 6 oz. of arsenate of lead dissolved in 8 gallons of water. This bait can be sprinkled on to the leaves or exposed in tins or bottles hung from the branches; strips of cloth or lamp-wick can be hung outside the vessels with one end in the liquid. The collection and destruction of fallen fruits will also help to control these pests.

Leaf-eating pests.—The young leaves are attacked by various caterpillars and beetles which can be controlled by spraying with arsenate of lead used at the rate of 2 lb. in 50 gallons of water, or 1 oz. in 12 pints.

Plant-sucking bugs, including scale insects.—These can be controlled by spraying with concentrated lime and sulphur used at the rate of 3 oz. in every 1 gallon of water, or about a 2 per cent solution. This is a combination insecticide and fungicide and may also act as a deterrent to many leaf-eating insects.

Of mango diseases the Acting Government Mycologist gives the three main fungoid diseases common in Ceylon and the preventive measures, as follows:

Mildew.—The mango mildew (*Oidium* sp.) occurs at high elevations and attacks the new leaves produced after wintering. It is a white powdery mildew and can be checked either by dusting with sulphur or spraying with some sulphur compound. A convenient spray compound is a proprietary lime-sulphur spray known as "Sulfinette." This liquid is convenient to use and does not clog the nozzles of sprayers. The spray employed should consist of a 1-2 per cent solution in water. The trees should be sprayed or dusted during the wintering period and two applications should be made at intervals of one week before the new season's foliage emerges. It is hardly worth while to dust or spray later since any damage already done cannot be rectified.

Red Rust (*Cephaleüros parasiticus*).—This is an alga which forms orange-red to rusty brown patches generally on the upper surface of the leaves. *Red Rust* is essentially a disease of weak plants and the first consideration therefore is to improve the vigour of the trees by cultivation and manuring. On small trees the alga can be attacked directly by spraying with Bordeaux mixture. Spraying should be done before the orange fruiting

patches appear on the leaves because at this stage the spray will not wet the parasite. The following mixture if added to the Bordeaux will make it more adhesive in wet weather:

Washing soda 1 lb.
Resin (common resin or colophony) 2 lb.
Water 1 gallon.

Boil the water, then add the soda. When dissolved add the resin and boil for about one hour stirring continually. Add this, when cool, to the Bordeaux mixture at the rate of 1 gallon to every 24 gallons of Bordeaux.

Anthracnose.—This is a disease which affects the young leaves, twigs and fruits and is caused by the fungus *Gloeosporium Mangiferae.* The fungus attacks the young leaves and twigs forming small dark areas and causes the shoots to die back. On older fruits black spots of various forms occur which are usually sunken and may coalesce to form large diseased areas and cause rotting of the fruit. The fungus can be checked on the shoots by cutting off and burning the twigs and spraying with Bordeaux mixture, and on the fruits hy spraying with Bordeaux mixture or "Sulfinette" 1-2 per cent solution in water about once a week after the fruits have set until they are mature.

Leaf Disease.—The fungus *Pestalozzia Mangiferae* forms minute angular grey specks sometimes coalescing to form irregular dark patches on the upper surface of the leaves. The fungus is a weak parasite and does very little harm.

The above deals with the main pests and diseases commonly met with in cultivation, but it is important to remember that prevention is better than cure, and good sanitation and cultivation with the maintenance of a vigorous healthy tree in the best possible condition is one of the best safeguards, and the results of judicious applications of fertiliser at the proper time are important means of controlling insect growth as well as fungoid diseases.

Other enemies are undoubtedly squirrels and birds, and the picking of the fruit in a very unripe condition is usually the unsatisfactory means adopted to forestall these attacks. The depredations of flying foxes on ripening fruits have to be contended with and frequent firing at them with a gun scares away such depredators for a time and appears to be the most practical remedy.

9. GENERAL

Enarched and budded mangoes should normally fruit at four to six years from planting but there is great variation of fruiting age among different varieties. The tree normally reaches maturity at ten to twelve years of age and full crops can be

expected from thence onward for a period of a further twenty-five years or so after which the tree would begin to decline in yield.

Though grown and used chiefly for dessert purposes the mango has a variety of other uses also and in recent years small canning factories have been started in India for the purpose of preserving this fruit. There are varieties for this purpose and also for culinary purposes in respect to chutneys and pickling. The fruit when green is used in curries both in the fresh and in the dried stage or can be made into a curry which has a sub-acid taste, or thin honey-like cakes are made by squeezing the juice on plates or pans and allowing this to dry.

In regard to canning a small trade in this is being developed in India. Preliminary experiments in canning undertaken in the Ganeshkhind Botanic Gardens with a steam pressure canning apparatus capable of developing a pressure of 30 lb. per square inch, have proved that this can be successfully accomplished and it is believed that a taste for the fruit so treated can be created. As many as 18,000 cans of mangoes so treated is stated to have recently been shipped to England in a single year and on receipt were reported on as being well preserved and that the fruit retained their flavour quite as well as do peaches canned in California.

In the cultivation of mangoes in Ceylon the initial steps desired are the production of good, high quality fruits for dessert purposes. The question of grading, packing, etc., for shipment, or facilities for canning can well be left to a later date when the fruit is produced in considerably greater quantities. A local market exists for all that can be produced for many years hence and there is little doubt that boats calling at Colombo would also create a certain demand if regular supplies are forthcoming throughout the mango season.

For these purposes however marketing conditions need to be studied to some degree, and the Fruit Report of the Imperial Economic Committee published in 1926 covers the ground admirably. The report emphasises a feature applicable at this juncture, *i.e.*, that all countries which have succeeded in establishing a fruit trade have done so by means of (a) the planting of sufficient areas of a single variety; and (b) by the process of grading all such fruit.

The selection of the variety suited to the locality is important and some assistance can be afforded in this respect if the imported plants already in the locality can be studied. There are many such in the Jaffna, Anuradhapura, and Negombo districts and such are of course very suitable localities for the mango. It is not suggested that one district or locality should restrict itself entirely to any one variety of the fruit, but where a variety is selected it should be one of the best for that locality and that if more than one variety is grown each should be in an area sufficiently large to supply a good market demand.

The question of grading for market purposes is an intricate one but if the grower limits his selection to one variety he reaps a considerable advantage over the grower of several varieties since in the latter case no two successive pickings would be uniform. Where the grower operates on a large scale it is possible for him to market his own fruit, but for the smaller grower a trade organisation is called for with agencies at various centres to purchase the fruit from the grower and, by recognised and uniform methods of grading and packing, create a regular market and stimulate demand for this luscious fruit. Considering that nearly Rs. 800,000 worth of fresh fruit is imported into the Island annually, it is evident that home production of high-class mangoes on a sufficiently large scale can materially assist in reducing these figures.

A PRELIMINARY REPORT ON THE TRADE IN AND CULTIVATION OF SPICE CROPS IN CEYLON*

THE spices which enter into the Ceylon trade are as follows:

Cinnamon, arecanut, cardamom, pepper (*Piper nigrum*), nutmeg, cloves, mace, vanilla, chillis (red peppers), ginger and turmeric.

Of these the last three form imports mainly from India.

The position as regards the trade and cultivation of these spices is summarized in the following table and statement, and details regarding the trade are furnished in the subsequent paragraphs:

1. (A) TRADE

Crop	Value of produce (average of last 3 years)	Proportionate distribution of trade in 1929 — U.K. and British Possessions	Foreign Countries	Remarks
	Rs.	%	%	
Exports				
Cinnamon	4,521,745	14	86	widely distributed
Arecanut	2,982,517	98	2	to India
Cardamom	762,599	30	70	distributed
Pepper	297,066	51	49	distributed
Nutmeg	35,240	74	26	mainly British India
Vanilla	13,986	100	—	chiefly United Kingdom
Cloves	13,127	99	1	mainly British India
Mace	2,017	100	—	British India
Imports				
Chillis	3,666,552	100	—	imported from British India
Turmeric	167,666	100	—	imported from British India
Ginger	70,576	100	—	imported from British India

(B) CULTIVATION

Cinnamon.—Regular pure plantations occur in the low-country in the Southern and Western Provinces and occupy about 25,800 acres. The cultivation is entirely in the hands of Ceylonese owners, and the majority of plantations are small varying from 20-50 acres. But there are many estates of 100 acres and in a few cases 200 acres and over. The crop comes usually in May-August and also in October-December.

Arecanut.—The estimated area is 68,800 acres distributed to varying extents in all districts but 47 per cent. of the total area is confined to the Sabaragamuwa Province. The chief district in which arecanuts are grown is Kegalle, over approximately 23,000 acres. This is not generally cultivated as a pure crop. More often trees are scattered indiscriminately over plantations, and a few trees may be found in every village garden.

Crops are obtained practically throughout the year, but more usually in August and in December.

Cardamom.—This crop is cultivated as a pure one mainly in the Central Province at mid elevation, 1500-3000 feet. The estimated area is 5,700 acres and plantations are chiefly on company-owned estates. The average

* Copy of report submitted to the Empire Marketing Board.

size of individual plantations varies from 50-100 acres, but three are many of 200-300 acres in extent. To a small extent plantations of 1-5 acres are owned by peasants, and small owners possess blocks of 20-30 acres.

The crop is gathered all the year round, but chiefly in February to March, and August to September.

Pepper.—This is not cultivated as a pure crop, and is found widely distributed in other plantations. While estates may have a few cases of pepper as a mixed crop, one or more vines may generally be found in peasant gardens.

Based on the produce exported and an average yield, it is estimated that the area under pepper is about 250-300 acres.

Nutmegs, mace, cloves, vanilla.—There are no regular plantations of these crops. Small patches of vanilla may occur on a few estates, and individual vines in peasant gardens. Nutmeg and clove trees are scattered about chiefly in the Central Province and receive no regular cultivation.

Chillis.—This is freely grown throughout the Island, but the crop is used in the unripe state. Cultivation is carried on, on a larger and more systematic scale in the Northern Province, and all efforts are being made to popularize cultivation on a commercial scale in other parts of the Island. The imports constitute dried chillis which are used as a comestible though differently from the unripe product.

Turmeric.—This is not cultivated in the Island.

Ginger.—This is not systematically cultivated except to a very limited degree in the Central Province, and it is used in the fresh state. The imported product is received in the cured or dried condition.

2. The following table shows the position of the spice trade during the three quarters of the present year compared with that of corresponding periods for last year:

Crop		First Quarter	Second Quarter	Third Quarter	Total for 3 Quarters
Exports		Cwt.	Cwt.	Cwt.	Cwt.
Cinnamon	1929	9,942	10,639	13,900	34,481
	1930	10,020	8,860	13,246	32,126
Arecanut	1929	36,695	24,747	44,337	105,739
	1930	28,648	16,903	30,719	76,270
Cardamom	1929	848	728	404	1,980
	1930	785	936	502	2,223
Pepper	1929	1,934	1,040	2,203	5,177
	1930	1,365	430	483	2,278
Nutmeg	1929	233	254	272	759
	1930	53	125	256	434
Cloves	1929	336	194	8	538
	1930	27	46	11	84
Mace	1929	3	20	6	29
	1930	—	4	6	10
Vanilla	1929	—	—	—	—
	1930	3	—	8	11
Imports					
Chillis	1929	41,376	33,550	25,527	100,813
	1930	46,031	36,647	34,751	117,429
Ginger	1929	804	604	676	2,084
	1930	927	568	836	2,331
Turmeric	1929	3,579	3,216	2,969	9,764
	1930	2,883	3,217	2,657	8,757

3. DISTRIBUTION OF EXPORTS

Cinnamon.—The trade is very widely distributed, and markets are found in no less than 24 countries, of which 9 are in Europe and 9 in North and South America, 8 are British and 16 foreign countries.

The largest buyers in 1929 were Mexico (9,300 cwt.), Spain (7,644 cwt.) U.S.A. (6,823 cwt.), Germany (5,853 cwt.), and United Kingdom (4,296 cwt.).

An appreciable expansion of the trade with the South American countries as well as with Germany and Holland has been taking place. Trade with U.S.A. is falling badly. Exports have been steadily increasing during the past three years.

Arecanut.—The trade is practically entirely with India and has been gradually improving during the past three years.

A small quantity is exported to Europe, but the trade is a very unsteady one.

Cardamom.—Trade improved in 1928 but dropped back in the next year. European markets absorb 65% of the exports, the chief buyers being the United Kingdom, Germany, Sweden, Denmark, and Norway. The trade with the United Kingdom, however, is steadily declining (1927—1,059 cwt.; 1928—1,036 cwt.; 1929—689 cwt.) while that with Japan has shown an improvement.

Pepper.—Trade dropped in 1928 to 2,916 cwt. but recovered remarkably in 1929 and reached 5,078 cwt. Markets are widely distributed, the chief buyers being British India 30%, United Kingdom 14%, U.S.A. 18%, and Mexico 12% of the total exports in 1929.

Trade with British India and Mauritius is expanding steadily, while that with the United Kingdom recovered well after a drop in 1928.

Nutmeg and mace.—Trade is entirely with British India and a slow advance is noted.

Cloves.—British India is the only market and a phenomenal rise in exports occurred in 1929, viz., 517 cwt., over 84 cwt. in 1927 and 67 cwt. in 1928.

Vanilla.—Exports have fluctuated greatly during the past three years—viz; 1927—24 cwt.; 1928—32 cwt.; 1929—6 cwt.

Trade is chiefly with the United Kingdom. U.S.A. took the bulk of the exports in 1928, but dropped out the next year.

Chillis.—Imports rose in 1928 but dropped in 1929 to below those of 1927. The rise in 1929 was helped by 2,263 cwt. from the Straits Settlements and 1,478 cwt. from Java. The bulk of the trade is with British India.

Turmeric.—Imports are steadily rising and the trade lies with British India.

Ginger.—The imports rose in 1928 but showed a slight decline the next year.

The bulk is obtained from British India, but last year small quantities arrived from Hongkong and the Straits Settlements.

4. Statements of exports and imports of spice for the past three years.

	1927	1928	1929
Exports	cwt.	cwt.	cwt.
Cinnamon	42,415	45,722	48,217
Arecanut	118,278	123,338	144,169
Cardamom	3,177	3,337	2,849
Pepper	3,880	2,916	5,078
Nutmeg	351	538	928
Cloves	84	67	517
Mace	27	31	33
Vanilla	24	32	6
Imports			
Chillis	146,488	151,124	140,111
Turmeric	10,685	11,099	12,995
Ginger	2,262	3,078	2,928

LATEX TUBE BORE THEORY

MR. ASHPLANT'S REPLY TO HIS CRITICS*

IN the South Indian *Planters' Chronicle* of 22nd November, Mr. H. Ashplant makes a reply to the critics of his Latex Tube Bore Theory. It should be explained that repeated attacks of fever compelled Mr. Ashplant to abandon his scientific work in South India in the autumn of 1928 and come to Europe for medical treatment. He returned in June of the following year with the intention of resuming his investigations into latex tube bore and publishing a full report on the subject. On the way out, however, he had the ill-luck to contract a serious throat trouble which entailed complete loss of voice for months and which failed altogether to yield to local treatment. This and the recurrence of his old fever necessitated his return to England in February of this year where he has been undergoing an operation. It is to be feared that medical reasons preclude Mr. Ashplant from again residing in the Tropics.

His prolonged illness has prevented him keeping in touch with recent literature on rubber, but from such extracts as he has seen he is of opinion that it would be misleading to regard Dr. A. Frey-Wyssling's paper (of which an account was given in *The Tropical Agriculturist* for March 1931) as an attack on the theory.

The tube bore theory, he contends, is merely going through the healthy process of criticism and investigation by other scientists, which is the lot of every new idea to science. It will be modified, as all new theories are bound to be, by later workers, but that latex tube bore as an important factor in latex yield will ever be displaced, or the main props of the theory overthrown, is to him and, he adds, to those who have seen something of the enormous body of evidence accumulated at the rubber Experimental Station, simply inconceivable.

Rightly understood, he claims, the investigations of Frey-Wyssling, far from attacking the tube bore theory, actually support it. "This, the first research into the problem since my own work, confirms the new factor as the most important determinant of rubber yield and at the same time it substantiates the two main claims I have endeavoured to establish:

"In the Report of the Experimental Station, 1928-9, I claimed to have made two observations: (a) That trees with latex tubes of below a certain average bore are almost invariably poor yielders; and (b) that good yielding trees just as invariably possess latex tubes of above this average bore; and I went on to say: 'Experience shows that from 55 to 65 per cent. of the trees on the average estates or in the average nursery belong to class (a). Tbe recognition in the nursery stage and the removal before planting of this class will enormously increase productivity.'

"With regard to the higher class of trees with tube bore above the minimum size, while there is a relation and a very marked relation between the tube bore and yield, the position of any tree in the class cannot be precisely indicated without a pre-knowledge also of the number of rings the tree will develop. No signs are known whereby the ring-forming potentialities of a tree can be determined in its infancy and until we have more knowledge of this factor it will be impossible to say whether a nursery

* From *The India Rubber Journal*, Vol. LXXX, No. 25, December, 1930.

plant will grow into a six, eight or ten-pounder tree. The close correlation between tube and yield might enable us to place a tree as good or very good in the (b) class with a high degree of probability, but all that I am concerned to claim here for tube bore measurements, is that they enable us to discriminate between the potentially poor and the potentially good. This is a big advance!

"Now, as to the claims made, Frey-Wyssling's paper also shows and admits that trees with narrow bore latex tubes are always low yielders.

"The second claim that good-yielding trees possess latex tubes of above average bore is confirmed by such of Frey-Wyssling's measurements as I have seen and it should be noted that the tube bores of all the AVROS' buddings examined were found to lie between 16 and 18 microns, all ranked, in fact, as 'A's' or 'B's,' the two classes in which for practical purposes we have been accustomed to group good-yielding trees in South India, it having been observed that good yield was always associated with trees with tube bore of from 15 to 20 microns. The chief difficulty was with trees possessing a tube bore lying between 13·8 and 15 microns any one of which might develop into passable yielders, given a high number of latex rings. An average tube bore of less than 13·5 microns seems to be incompatible with good yield, excepting very rare cases where the number of latex rings is phenomenal.

"So far as the main principles go, then the Dutch investigator's researches are a vindication of the tube bore theory, where he diverges from me is in the degree of correlation observed, and hence in the utilisability of the theory.

"The number of trees examined by Frey-Wyssling was absurdly few and I have no doubt that the difference between the correlation coefficient found by him of 0·54 and that by me of ·075 is partly due to this. It is also partly explained by the selected nature of Frey-Wyssling's material. He concluded in his tables no tree with tube bore of less than 14 microns, which will seem an unfair assortment when it is pointed out that 128 of the trees figuring in my tables or 50 per cent. have tube bores of from 13·5 down to 10·5 microns.

"I am indebted to Mr. G. N. Frattini, who has kindly re-examined the tables, for pointing out that if in my correlation material all individuals of less than 14 microns diameter are omitted, a correlation of 0·537 is obtained.

"I will not emphasise the clones agreement of this figure with that of Frey-Wyssling. There will be time enough to discuss correlation values when Frey-Wyssling or some other investigator tackles tube bore measurement on a comparable scale.

"With regard to the choice between budding and tube bore selection, this depends upon local circumstances. There is no question but that propagation from the few *elite* trees which have been proved to transmit their desirable qualities of high yield and vigorous growth must be preferable to selection from the common herd, whether the selection is by tube bore or any other test. All that any test applied to the ordinary population can do is to weed out the unfit. For the real aristocrat among rubber trees may occur but once in ten thousand. The discovery of a mere dozen *elite* trees has taken the Dutch East Indies over 12 years, and even in regard to some of these much uncertainty prevailed up to a year ago. Outside the Dutch East Indies no really proven bud mothers of local origin were available, and in the prevailing uncertainty a method of eliminating the duds, such as that worked out by me, was more dependable than budding adventures with unknown and frequently brown bast tainted stock. It was infinitely preferable to the indiscriminate planting still going on when I introduced my method, and when the real test of actual tapping can be undertaken, 'later-day Buddists' will have no cause for dissatisfaction with the tube bore selected areas.

"IF BUDDING HAD COMMENCED FIVE YEARS EARLIER"

Referring to budding and the present situation in the rubber industry, Mr. Ashplant says: "If the scientific critics of my theory who are, in the rebound, showing such enthusiasm for budding had, years ago when budding was unpopular, displayed a little more courage and foresight, the rubber industry might not have reached its present 'impasse.' Up to four years ago I was the only scientific man in British planting circles who foresaw the possibilities of budding and pressed its adoption on the planting community, and it should not be forgotten that it was the bright idea of pruning bud mothers, originated by me, that made budding practicable in South India and Burma, not to mention some parts of Ceylon.

"Though sighs for lost opportunities will not now recall them, one cannot help wishing that interest in and research into methods of increased production had commenced five or ten years earlier, instead of with the first serious price decline. Had large highly-selected plantations, capable of yielding 700 to 800 lb. per acre, been in existence by, say, the year 1919 it is safe to say that much of the vast native area with its uncontrolled riot of production, would never have been planted. Any fool can plant rubber and to the far-seeing it has always been evident that a thing that offers an easy profit to anyone would eventually, be overdone unless more efficient methods demanding greater intelligence were introduced. The tragedy is that we have waited until the planting of rubber was overdone, almost before we generally awoke to the danger. By failing to apply science in the one direction in which European skill and resource could achieve definite superiority, *i.e.*, in securing higher productivity, we have temporarily lost the race.

"Nothing can now avert a brutal period of economy and readjustment, which is likely to be very prolonged unless rubber producers, like other business men, realise the folly of producing at a loss and rest their plant until demand revives.

"We have suffered too much from optimists in the rubber industry, particularly from the prognosticator of 'booms.' If continued production is a form of optimism, the sooner we have a little pessimism the better.

"The rubber-planting industry has one unique feature which may be a matter for self-congratulation or otherwise according to whether we think of ourselves or our competitors, but is in any way of benefit to the world at large. It has the immense advantage over other industries of a plant that improves when left idle. If there is another consoling reflection, it is the economic truth that no useful commodity can permanently remain below its cost of production."

RICE CULTIVATION IN ITALY*

IN accordance with instructions from the Colonial Office, I was privileged to visit the Rice Experimental Station at Vercelli (Italy) in order to study the latest methods employed there for the improvement of rice cultivation generally.

The Rice Experimental Station was founded in 1908 and is financed chiefly by contributions from the cities of the province (IL Vercellose), the Chamber of Commerce, the Farmers' Syndicate and by Government.

The definitions and explanations of measures, etc., given in this article are as follows:

(1) Hectares—2·47 acres.
(2) Quintal—100 Kilos—220 lb.
(3) Kilo—2·2 lb.
(4) Paddy—Grain before being husked.
(5) Exchange—93·25 lire to £1.

The Institution is separate from the Agricultural Department and is devoted entirely to the improvement of rice and experimentation with fish (*carp*). The work is divided into the following sections:

(1) Agriculture
(2) Machinery
(3) Chemistry
(4) Genetics
(5) Fish

There are also thirty hectares (74·1 acres) of paddy land under the control of the Institute for experimental work. The following is a brief *résumé* of the class of work done under each of the above sections:

1. Research work with new varieties, both in the field and at the experimental station. The selection of seed in mass on the farms, manurial trials and the general study of new methods of rice cultivation.
2. The study of rice agricultural machinery. At the present moment the improvement of the machine for transplanting rice is being worked upon. The officer-in-charge of this branch is a fully qualified engineer.
3. Research work connected with rice, manures, and soils.
4. Hybridization and pure-line selections.
5. Experimentation with carp and propaganda work.

The area under rice cultivation in Italy at the present time is approximately 150,000 hectares (370,500 acres) and I was informed that this area will not, to any extent, be increased in the near future, chiefly because of the system of agriculture practised and also that all suitable irrigable land is already under rice cultivation.

It is estimated that 90-95 per cent. of this area is situated in the North of Italy.

---

* By F. Burnett, M.C., M.A. (Oxon.), Deputy Director of Agriculture in *The Agricultural Journal of British Guiana*, Vol. III, No. 3, September, 1930.

The farms can be divided into two distinct classes, (1) large farms of between 200 to 300 hectares (494-741 acres), and (2) small farms of 10-15 hectares (24·7-37·05 acres) each. An interesting point about these is that the small farms are generally owned, whilst the large farms are generally rented. The rent for paddy land is paid in kind, varying from 10 to 15 quintals (2,200-3,300 lb.) according to the richness of the land per hectare. All the paddy is grown on irrigable land and there is an ample supply of water.

There are very few varieties grown, compared with other rice-producing countries—estimated to be less than twenty, of which the following are the chief:

1. Americano 1600 (awnless).
2. Ostiglia (awned)
3. Bertone (awnless)
4. Lencino (awned)
5. Ranghino (awned)
6. Nero Vialone (awnless)
7. Orijinarios (awnless)†
8. Onsen†
9. Sekyama (awned)
10. Sancius (awnless)
11. Precoce (awnless)
12. Precoce Declarole (awnless)
13. Precoce Allorio (awnless)
14. Precoce Giallo (awnless)
15. Precoce Vittoria (awnless)
16. Maratelli.

The chief kind grown is the original Chinese variety (*Originario cinese*) and it is estimated that four-fifths of the whole area is under this variety. The varieties above marked † sign are also heavy yielders. The age of each, from the time of sowing to maturity, varies from 5 to 5½ months. Only one crop of paddy per year is grown. The yield per hectare for the 1930 crop was estimated, on an average, at 55 to 60 quintals (5-6 tons) equivalent to 100 to 120 bushels per acre.

Every year the Institute imports new varieties from other rice-growing countries, but from Japan and America chiefly. These varieties are sown on the Experimental Station, and if they show signs of conforming to requirements, *i.e.*, heavy yielders, even samples for commercial use, freedom from disease, they are then given out to various large farmers for trial and acclimatization. Some farmers have as many as 15 to 20 varieties in small lots. I was privileged to visit several of these farms, and the variation in growth and the age of ripening was, as usual, very great. The best varieties are, however, eventually harvested and seed kept for further trial. It takes two or three years before a new variety becomes acclimatised. Varieties even vary in time to maturity when exchanged between the North and South of Italy. Where a variety has been found suitable, the area is gradually increased each year. This was the method employed with the variety Americano 1600. The seed was only imported in 1920, and it is estimated that four-fifths of the whole area under rice cultivation is now grown with this variety. Seed in large quantities is not distributed from the experimental station.

There is no dry rice cultivation.

The typical rotation in the region most intensively cultivated with rice (IL Vercellose) is the following:

1st year—Wheat.

2nd ,, —Meadow land.

3rd ,, —Meadow land with casual maize and transplanted rice.

4th ,, —Rice.

5th ,, — ,,

6th ,, — ,,

7th ,, — ,,

General cultivation commences in April. The only difference in the general methods of cultivation of rice following wheat and rice following rice is that transplanting is necessary after wheat, instead of broadcasting, to ensure its ripening at the correct time. Every precaution is taken to ensure that the crops are ready for reaping in September, as the harvesting season is short and different from other rice-growing countries where this season is much longer.

Before ploughing the land, farmyard manure is applied in varying quantities according to the amount available up to 400 quintals (approx. 40 tons) per hectare. The land is then ploughed and on some farms, where the tractor is used, the harrow is also attached to the plough, and both operations carried out at the same time.

Tractors are only used on the large farms. On the smaller farms ploughing is done by means of horses and oxen.

Where farmyard manure has not been applied, artificial manure is applied at the time of sowing at the following rate per hectare:

8 quintals (1,760 lb.) of superphosphate.

3 ,, (600 lb.) of potassic manure and if the crop requires it.

1 quintal (220 lb.) of sulphate of ammonia after weeding.

One farmer informed me that he used sulphate of ammonia only, at the rate of 250 kilogrammes (550 lb.) per hectare.

The soil is then harrowed a second time and irrigation commences. After 4-5 days the soil is well mixed by means of a puddling machine drawn by a tractor or horses. Levelling is, however, done entirely by hand implements.

Before sowing commences, either in the nursery or in the field, the seed is selected by a machine. This machine is in use on large farms, is popular and effective. On small farms sowing by hand is still in practice.

It is estimated that 25 per cent. of the total rice area is transplanted. A machine for transplanting is in use, but it is not yet very popular. This undoubtedly is due to the failure of various types of transplanting machines that have been previously placed on the market. The latest machine is claimed by the Institution to be fairly successful. Last season it was estimated that, out of 35,000 hectares (86,450 acres) transplanted, about 5,000 were planted by the above type of machine. The work of transplanting with this machine has to be done slowly, and with very little water in the fields. Horses dragging the machine have to be changed every two hours. It is estimated that one hectare can be transplanted in one day. The plants, whether by machine or by hand, are planted in threes and fives at 8 inches apart. If transplanting is done by hand, it is estimated that it will take 40-45 women one day of 8 hours to transplant one hectare.

The sowing of the seed on the remainder of the area—115,000 hectares (284,050 acres)—is done by machines on the large farms and broadcast on the small farms. This type of sowing machine has been evolved after considerable experimentation, is efficient, and very popular.

The rate of sowing is 150 kilogrammes (330 lb.) per hectare. Thinning-out is done both by machine and hand. Where the seed has been sown by a "drill" or transplanted by a machine, then weeding with a horse-drawn machine is possible. This type of machine is considered most satisfactory. When the crop has been broadcast, then weeding is done by hand.

The harvesting is done entirely by hand by means of a sickle. The water is drawn off the fields about 14-21 days before harvesting commences and clover sown (*Trifolium incarnatum*). Reaping machines are not in use, and attempts made so far have ended in failure. Several types have been tried, both horse and hand motor reaping machines, but they have not been successful.

The crop is then carted to the homestead and threshed by means of a threshing machine. On large farms the machine is fixed. The small farmer gets his threshed by means of an itinerating threshing machine, *i.e.*, on the same principle as the English small farmer gets his corn threshed.

It is estimated that about 16 quintals (3,520 lb.) can be threshed in one hour. The grain is then winnowed and dried.

The winnowing machine is called a *pulitore*, and the drying machine an *essiccatoio*. Due to uncertain weather for drying the grain, artificial drying is resorted to, although on the small farms it is sun-dried by being placed in the sun on cement and asphalt floors. Unless the paddy is to be husked and polished, it is now ready for sale. Both the large and the small farmers dispose of their crop as paddy, which is generally purchased by the rice millers who prepare it according to the demands of the different markets. The rice in some cases is not polished, owing to a lower export rate for unpolished rice, and it depends on the market price whether or not it is profitable to polish.

Both the paddy in the rough and cleaned rice are sold to private stores. The charge for husking and polishing 100 kilos (220 lb.) is 7 lire ($0·36) plus the by-products after husking.

The proportion of rice to paddy is 63-65 per cent. and the remainder is made up of 20 per cent. husks, 9 per cent. broken rice and 6 per cent. meal. The husks are used as firing material, the broken rice is generally converted into beer and there is also a market for the meal. These private stores are established in every large rice-producing district in the North of Italy and are entirely privately owned. In Vercelli town there were seven such factories of commerce.

I was informed that there were no co-operative buying or selling institutions in operation as far as rice is concerned.

The crop everywhere is fed entirely throughout by means of irrigation and does not depend on rain water. There is a water rate levied, amounting to between 250 and 300 lires ($12·87-$15·44) per hectare per annum. The consumption of water varies in the following manner:

Clay soils	1·5 litres (0·33 gallons) per hectare daily
Intermediate soils	2·5 litres (0·55 gallons) per hectare daily
Light soils	5·0 litres (1·10 gallons) per hectare daily

There is no malaria in the rice-growing districts now, although I was informed that the mosquito is still found. The eradication of fever is thought to be due to better sanitary conditions and also to the growing of crops in rotation in irrigated fields.

It is estimated that 25-30 per cent. of the crop is exported yearly, the chief countries outside Europe being the Argentine and Chile. Rice is eaten in Italy, mixed with vegetables in soup, curried with meat and ground into flour.

In my opinion the flavour of the rice is not as good as that of some of the varieties grown in Ceylon, nevertheless it should be maintained that Italian rices are regarded with favour on the international market.

The price of manual labour varies from 15 to 20 lire ($0·77 to $1·02) per day according to the grade of workman and time of the year. During the harvesting period, 20 lire ($1·02) a day is paid. Women are paid a little less, but, during harvest, 18 lire ($0·95) a day is paid.

As far as I could ascertain no assistance or support is given to the farmers from Government excepting through and by this Institution. Money, however, can be borrowed from agricultural banks at the rate of 6½ per cent. on security of the crop after inspection.

There are no pests of importance. A recently imported variety of paddy had, however, met with misfortune and had completely died out. The crop had grown and eared well, but just before ripening it entirely failed. This is one of the difficulties of acclimatization, in spite of the success of this variety the previous year.

The study of economics of rice cultivation has not yet been attempted at the Institute. The labour question, however, is not, I understand, a difficult one, and during the busy times of the year the farmers co-operate and help each other.

In *IL Giornale de Risicoltura* for June 1929, full details are given of the methods of hybridization employed at the Institution. By this method 95 to 97 per cent. successes are obtained.

The names and addresses of firms supplying the rice machinery now used on the farms are as follows:

Agricultural Machinery ...	Cabbrini and Mocchi, Pavia
Husking and Polishing machine ...	Morandi and Minghetti, Vercelli, Italy.
	P. Cattananeo and Figli, Pavia, Italy.
Threshing machines ...	Brusa Vittore, Vercelli.
	Sacerdate, Coutoni & Co., Vercelli.

I was able to obtain a wide range of photographs dealing with rice cultivation in its various stages, but, as space will not permit publication, I shall be happy to loan them to anyone interested.

ROOTSTOCK INFLUENCE IN FRUIT GROWING*

THE fruit grower has always found one of his outstanding difficulties in the variability of his produce. The fact that varieties seldom, if ever, come true from seed, caused in the first instance propagation by seed to be abandoned in favour of a vegetative method which reproduces completely the characteristics of the parent plant. As, however, not all desirable varieties are capable of producing suckers or forming adventitious roots from the stem for layering, it has been found in practice preferable to bud or graft the variety with desirable fruiting qualities on to an independent root system. Thus the great majority of the tree—fruits, such as the apple, pear, plum cherry, peach, citrus fruits and, in some countries the vine, are produced by means of budding or grafting and hence are composite structures made up of two individuals the scion and the rootstock.

Variability is not, however, entirely eliminated by means of the composite tree. That the rootstock may influence the tree in certain ways has come to be recognized by nurserymen and growers, at any rate, in Western Europe. The rootstock may be a seedling or may be formed by layering some readily rooting variety. There has been a widespread idea that a seedling stock will give the vigour of growth necessary for an orchard tree, while a layered stock is shallow rooting and will produce a small and comparatively early cropping tree. Since the scion variety is in reality a single individual, any difference must be attributed to the influence of the stock, and the recognition of this fact caused studies of the two kinds of fruit tree stocks in common use in Western Europe to be undertaken in Engand in 1913.

The variability of the seedling stock was recognized by growers as being often reflected in the scion but was regarded as inevitable on account of its origin. It was a common experience for a grower who had stocked his orchard with a single variety in apparently uniform conditions to find the trees developing the most diverse habits of growth and cropping capabilities. To quote an actual case: some early Victoria apples, budded on seedling stocks, were selected from the nursery as one-year-olds for their uniformity in size. Twelve years later at Malling the trees range from spreading dwarfs to vigorous upright trees and their cropping is equally varied. The best trees in the group bore at the rate of 51 tons an acre and the worst at the rate of 10 tons. This means that the grower of a mixed lot of trees such as these would at the end of 13 years from planting have harvested about 28 tons of fruit per acre, whereas if he could have standardised his trees to produce at the rate of the best he would nearly have doubled his crop.

The standardisation of seedling stocks, in the first place for the apple, was undertaken by the Research Station at Long Ashton, Bristol. An attempt was made to obtain uniformity by finding typical vigorous seedlings suitable for the production of orchard trees which were also capable of being propagated by vegetative means. This object was achieved in the rootstock now known as Bristol V, which is layered but retains its deep rooting system and gives a large slow-cropping orchard tree.

---

* From *International Review of Agriculture*, Year XXI, Part I, No. 5, 1930.

This orchard rootstock fulfils the growers' requirements, of uniformity but from the economic point of view it has lost the seedling stock's advantage of easy and cheap production, and other methods of obtaining uniformity may be desirable. One method suggested is the grading of seedling stocks in the nursery. It is recognised that the nursery practice used in producing a standard tree necessitates a certain amount of selection to obtain the required height of stem, the weaker stocks being eliminated in the process, but this entails waste and again increases the cost of production.

The process of "bench grafting" which is much used in the middle west of the United States, seems to bring about a considerable degree of uniformity in the orchard. The scion is grafted directly on to a portion of the tap-root of a seedling stock and it is now thought that by this means the influence of the stock is eliminated. It has been shown that the root system of the resulting tree is so much influenced by the scion that varieties can be distinguished by their roots alone. This method would seem to be entirely satisfactory if uniformity in the orchard was all that was to be desired and if different climates, soils and purposes had not to be taken into consideration. It is obvious that if the individual characteristics of both the rootstock and the scion can be retained and their interaction understood, a far wider range of possibilities is opened up.

That the stock has a far wider influence than was at first realised has been discovered by the East Malling Research Station, which undertook the study of layered stocks in 1913. The work was begun with the object of identifying the different vegetatively propagated rootstocks in commercial use. The layered stock which at least should be uniform, was frequently misnamed and not true to type, and considerable confusion arose, because the nursery men did not know the possibilities of the young trees. Perhaps a variety sold to a grower as being on a "Paradise" or layered stock and therefore suitable for interplanting between his permanent standard trees, turned out to be as slow-growing and wide-spreading as the permanent trees; he had to wait eight or more years longer than he expected for any return on his outlay and in addition his orchard became overcrowded.

The analysis of these stocks at Malling soon showed that the so-called dwarfing stocks consisted of 17 varieties which could be divided into four groups showing striking differences in their influence on the tree.

The following table shows a comparison of the size of trees and the cropping capacity of Lane's Prince Albert worked on a representative of each of the 4 types and grown on good medium loam at East Malling:

Table I

Stock	Suitable number of trees per acre.	Crop returns per acre (bushels)	
		Total for first 4 years.	Total for first 7 years.
Dwarf IX ...	504	106	1,123
Semi-dwarf II ...	268	34	590
Vigorous I ...	150	4	302
Very Vigorous XVI	101	...	152

It is seen that the relative order of cropping in early years is the converse of that of vigour and from the space required that the trees on stocks I and XVI develop into fully-sized orchard trees. The results of

this work are that (1) the grower can now plant one variety, if he so desires, as permanent trees and fillers, because he knows the relative vigour of the rootstocks, (2) he can be certain of early return from the dwarf trees, (3) he knows how to space the trees when planting so as to make full use of the ground when the larger trees have come into full bearing, and (4) he can make his provision for tillage operations knowing with considerable accuracy the type and size of machinery which will be suitable. Such a measure of control more than compensates for the extra cost of a layered stock.

Similar trials on different soils with the same variety on the four types of stocks have shown that the rootstock must be selected in relation to soil conditions as well as to the purpose of the tree. It was found that the absolute size of the tree on any given stock differed markedly on different soils, yet in each case the relative vigour and precocity remained the same. Table II shows the behaviour of two very different varieties on the four stocks on different soils.

Table II

Soil type	Dwarf	Semi-dwarf	Vigorous	Very Vigorous
			Bush Lanes	
Medium Loam	Moderate	Good	Vigorous	Very vigorous
Sandy Loam	Small	Moderate	Vigorous	Vigorous
Heavy Clay	...	Moderate to poor	Good	Vigorous
Light sand	Very poor	Poor	Small	Moderate
			Bramleys	
Medium Loam	Good moderate bush	Vigorous	Very vigorous	Too vigorous
Sandy Loam	...	Good	...	...
Heavy Clay	Very small	Good, Small	Good	Vigorous

It is hoped in time to be able to construct similar tables for all possible combinations of soil and variety.

Another characteristic which appears to be influenced by the rootstock is the time of blossoming. Control of this feature is of value from two points of view: in places liable to late frosts it is advantageous to be able to grow trees on vigorous stocks which cause late blossoming, and in view of the present knowledge of self-sterile and inter-sterile varieties it is obviously useful to be able to ensure that two varieties which are planted together for pollination purposes will be in blossom at the same time.

Fruit quality as expressed in colour and size is another character which is most certainly influenced by rootstock. It has been found that the very dwarfing stock, Malling Type IX, produces pre-eminently fine quality dessert apples which are larger and appear riper than fruit of the same variety picked from other stocks, and are equally good for storing. On the whole the more vigorous stocks tend to give less colour, the apples appearing green when ripe on vigorous Type XVI, and the fruit tends to be smaller on vigorous stocks, though size is apt to fluctuate from year to year on the same tree. It is evident that in the nursery certain apple stocks are far more susceptible to certain diseases and pests, such as canker (*Nectria galligena*) scab (*Venturia inaequalis*), mildew (*Podosphaera leucotricha*), crown gall (*Bacterium tumefaciens*) and leaf scorch than others, and facts are gradually accumulating from orchard experience and direct experiments which show that the varying susceptibility is transmitted to the scion.

Investigations into the nature and effect of pear, plum, peach and cherry stocks have also been carried out at Malling. In each case the commercial stocks were found to lack uniformity, and the first work was directed towards bringing order out of chaos.

In the case of pears it has been found that certain of the quince stocks in common use show a marked "incompatibility" with certain varieties, which explains many previously unaccountable failures in the orchard. Some quince stocks have been found to induce earlier fruiting than others. It has been possible also to select and propagate vegetatively a series of a pear rootstocks which will give a wide range of performance when grafted with a given variety. There are indications of disease resistant pear stocks and in America pears on certain rootstocks have been found definitely more susceptible to a physiological disease known as "black-end" than others, some often showing 100 per cent. immunity and others 100 per cent. susceptibility.

In the work with plum stocks for plums and peaches striking evidence has also been obtained of "incompatibilities" and of stock preference with several of the common commercial varieties. And although at present it is not as easy as in the case of apples to control the size of the plum or peach tree by the influence of the stock during its development, it has been found possible to vary its period of blossoming and habit of growth by this means.

Thus the variability which was one of the chief obstacles to successful fruit growing has been brought under control and turned to account. It is possible for a grower to-day to predict with considerable exactitude over a wide range of conditions of soil, variety, etc., the approximate size to which an apple tree will grow, the age at which it will come into cropping, and even other factors such as its period of blossoming and its propensities to certain diseases and pests, and the size and quality of the fruit itself. There is also already sufficient evidence obtained from work on the stone fruits and citrus fruits to show that the day is probably not far distant when it will be possible similarly to control by means of the rootstocks all fruits grown as composite structures.

THE STORY OF TWO DECADES OF CHEMICAL RESEARCH ON PADDY SOILS IN THE MADRAS PRESIDENCY*

PADDY or rice (*Oryza sativa*), being one of the principal food crops of Southern India occupying the largest portion of the cultivated area was the first to receive the attention of the Department of Agriculture since the commencement of agricultural research in this Presidency.

This article deals in popular language, with the investigations bearing on the study of the soil, the crop, the inter-relations that exist between soil conditions and crop growth, the mode of action of manures and the influence of manuring on the crop.

The practice of agriculture in its early days was based almost entirely on the results of accumulated experience. The cultivator had but little idea of the changes taking place in the soil or of the process controlling the fertility of the land. In consequence he was often unable to circumvent adverse influences. In course of time however, it was recognised that the factors involved in crop production were many and varied and the aid of science was invoked with the result that modern agriculture is a fabric built on a scientific foundation based on the labours of an army of investigators in a number of sciences all working in close collaboration with the practical farmer.

It is obvious that plants require food material for their growth and that as they thrive only in the soil, the food must come mainly from that source. The most important of these food constituents, from the point of their absorption by the plant in large quantities, are nitrogen, phosphoric acid, and potash. Investigation has shown that all the plant food present in the soil is not in a form capable of being utilized by the growing crop. Plants can take in their food only when it is dissolved in water and that portion of the plant food in the soil which is not soluble in water is of little immediate benefit to the crop. It is therefore customary to speak of the 'total' and 'available' plant food in the soil, the latter being that portion which is soluble in soil water and which can be at once taken up by the crop. It is thus clear that the 'available' plant food in a soil is the factor of chief interest to the cultivator as, other conditions being satisfactory, its amount will, within certain limits, determine the yield of crops. The total plant food is not without interest to the ryot. It is in fact an item of reserve deposit from which small quantities are drawn from time to time. There is, in other words, a slow conversion of insoluble material into soluble plant food for the gradual use of the crop and it is this change which enables soils to go on producing crops for very long periods even though no plant food is added in the form of manure. But if land is continually cropped, there must be a constant drain on the food supply present in the soil till it reaches a stage of minimum availability.

The yield from an acre of normal paddy crop (3,000 lb. grain and 3,000 lb. of straw) has been found to contain 48 lb. of nitrogen, 23 lb. of phosphoric acid and 41 lb. of potash and these constituents must have

* By B. Viswanath in *The Journal of the Mysore Agricultural and Experimental Union*, Vol. XI, No. 3.

come from the soil. If we visualize the soil as a bank, it is obvious that, unless what is withdrawn is returned, the account will soon be overdrawn. But wise Nature has foreseen man's greed and in her infinite wisdom has provided against his sins of commission and omission by setting up in the soil a mechanism for the indefinite supply of the bare minimum requirements, for what is ordinarily termed the minimum crop production. So that, if the few pounds of the manurial constituents taken off from the soil are not returned, there will not be a complete cessation of crop growth, but there will result crops poor in quality and quantity which means an inferior and insufficient food which in consequence produces a devitalized population falling an easy prey to all sorts of diseases.

It is a matter of great practical importance to ascertain to what extent the loss of plant food has proceeded, what reserves are available, and whether the soil is producing the maximum crop which it is capable of producing under proper management. To this end soils surveys of the more important paddy tracts throughout the Presidency were carried out. Many hundreds of samples, typical of the soils of each tract, have been collected and analysed. These surveys have yielded very striking results and show in a very marked manner how very deficient our soils are in certain ways and the large areas which demand immediate manurial treatment. The following tabular statement explains the nature and extent of the deficiency :

No.	Name of tract	Percentage of the soil deficient in: Nitrogen	Phosphate
1	Godavari ...	40	23
2	Kistna ...	33	55
3	Guntur. ...	80	33
4	Tanjore ...	87	80
5	Periyar ...	0	90
6	Malabar ...	0	90

The surveys have, therefore, indicated, in a very definite manner the enormous loss in crop production which is taking place throughout the Presidency owing to the exhausted condition into which the soils have been allowed to fall, either through the ryot failing to appreciate the importance of manures or more usually through his inability to afford the cost of manures. Loss in yield, however, is not the only injury which results from the widespread deficiency of phosphoric acid. The results of experiments at Coimbatore have shown very clearly that in cases where phosphoric acid was deficient, not only was the yield reduced, but the composition of the crop was affected. Both grain and straw contained much less phosphoric acid than the crop from properly manured plots and hence the food value of the crop was much diminished.

The practical utility of the investigations mentioned above is obvious. With the aid of these soil analyses it has been found possible to ascertain the manurial needs of the areas and that of the paddy crop with the result that the nature of action of manures began to be investigated. The results of a large number of experiments in the field and in the pot culture house spread over a number of years have shown that all the natural and artificial nitrogenous manures are more or less beneficial to paddy but that they are more economical when applied in conjunction with bulky organic manures. Of the latter class of manures, green manures are pre-eminently suited to paddy crop. The results of the manurial experiments may be briefly described in numerical values comparing the relative merits of the different

systems of manuring with that of green manure, taking the value of green manure as the unit of standard.

No.	Manure applied		Relative efficiency
1	No Manure	...	0·33
2	Phosphate alone	...	0·50
3	Nitrogen alone	...	0·70
4	Nitrogen *plus* Phosphate	...	0·90
5	Green Manure	...	1·00
6	Green Manure *plus* Phosphate	...	1·20
7	Green Manure *plus* Nitrogen	...	1·33
8	Green Manure *plus* Phosphate *plus* Nitrigen	...	1·60

Potash is not included in the investigations as our soils are generally well supplied with this constituent.

The numerical values mentioned above refer to the results of pot cultures. The results of field trials are of a simpler order.

These experiments show that of the three most important manurial constituents, namely, nitrogen, phosphoric acid, and potash, the last-named does not appear to be necessary except perhaps in rare cases or where it is indicated to counteract disease. Nitrogenous and phosphatic manures are in general need and are responded to by the crop when applied singly or together, but their effect when combined is better. Phosphatic manures have been found to stimulate the assimilation of nitrogen which would otherwise not be utilized and also to enrich the composition of the crop in this constituent thus enhancing the nutritive and seed value of the grain.

It is seen that artificial manures are not as efficient as green manures for paddy and that the efficiency of either class of manures can be considerably improved by combining them. This raises the question as to the proportion in which artificials and green manures should be used. In so far as the Coimbatore soils are concerned, it would appear that a mixture of two-fifths of artificial nitrogen and three-fifths of organic nitrogen make a suitable combination for paddy. Larger dressings of green manure appear to render supplements of artificial nitrogen like sulphate of ammonia ineffective.

The study of the soil conditions and the nutrition of the paddy plant with special reference to the practice of green manuring marks a distinct advance in our knowledge of the nature of action of green manure under puddled and swampy conditions.

Paddy in this Presidency is generally grown under swampy conditions and in a puddled soil throughout the growing season, and yet no general system of cultivation holds good for all tracts, so that it cannot be said that the system adopted in one locality holds good in another In South Malabar, the general practice is to plough the lands in the dry season with excellent results, but this practice introduced into the deltaic tracts resulted in failure. Green manuring is found beneficial in one area but when tried in another the crop fails. In some places water may be run on to fields and puddling and manuring done weeks before the crop is planted, but in other districts the custom is to put in the green manure just before transplanting. These and other mutually opposed facts make it essential that the conditions governing the growth of paddy should be closely studied in order to obtain, if possible, some common basis capable of explaining them before any improvements in paddy cultivation can be considered.

Since green manure undergoes putrefactive fermentation when buried under water, it was considered that an examination of the soil gases would make an opening to the problem. The first investigation showed that the normal fermentation of green manure in swamp paddy soils leads to the production of different gases and that the introduction of a crop into the field modifies the proportion in which some of the gases are produced and inhibits the production of others. The soil conditions are found to be anaerobic in character and therefore, nitrification is impossible and the nitrates produced during the period when the soil was dry are quickly denitrified. Under these conditions, therefore, the nitrogen required by the crop is obtained in the form of ammonia and probably from other nitrogenous organic compounds produced by the anaerobic decomposition of the proteins in the green manure.

Certain substances formed as a result of this decomposition are toxic to the crop and should be removed in the drainage water or should be destroyed by prolonged decomposition before seedlings are transplanted.

A more detailed study of the soil gases has revealed the fact that the gases escaping through and at the surface of the water in the paddy fields, are different from those that are present in the soil themselves and consist mostly of oxygen and nitrogen as against marsh gas, hydrogen and carbon dioxide that are formed in the soil. A certain relationship was also noticed between the evolution of and the presence or absence of crop, and pot experiments have clearly shown that the effect of the crop is to diminish the evolution of oxygen. This means that the evolved oxygen is absorbed by the crop for its growth. A careful examination of paddy roots of different types has shown that the roots of paddy do not resemble those of typical aquatic plants, but are similar to those of ordinary dry land crops and as such require oxygen to be healthy and strong. The supposition is, therefore, correct that the oxygen is used up by the crop for aerating its roots.

The evolution of oxygen has been traced to a film of algae commonly seen on the surface of paddy fields and this film is found to contain bacteria which oxidize hydrogen and marsh gas with production of carbon dioxide. The carbon of this gas is utilized by the algae for this food-liberating oxygen which dissolves in the soil water and aerates the roots.

If the oxygen dissolved in the surface water is to aerate the roots, the water charged with oxygen should be capable of reaching the root zone, and this is possible only if there is drainage; so that drainage is an important factor. If the soil is badly drained the oxygenated water cannot enter the soil and consequently aeration would be restricted to the surface layers.

On the other hand, in well-drained soils, the aerated water would penetrate deeper into the soil. Consequently it appears reasonable to presume that the better the drainage, the deeper would be the aeration and therefore a proportionately increased cropping. If this is the case aeration can be promoted by a thorough periodical draining of the soil.

Actual experiments have shown that this is not the case. The mere draining of the soil is inadequate for the purpose. The simple system of slow movement of water through the soil and therefore through the root range has been found to be most beneficial for the crop. The reason for this has been found to be that the water percolating through the soil is strongly charged with oxygen and therefore supplies plenty of it to the roots; whereas, the simple admission of air into the soil by thorough draining would yield only a weak solution of oxygen.

The best results are abtained with a moderate amount of drainage and too slow or too rapid drainage would result in decreased cropping. The reason for this has been traced to the fact that the development of the film which is responsible for the supply of oxygen occurs best under moderate drainage conditions. Thus the most efficient drainage in paddy soils is not the quickest but one that permits the surface film to maintain its full activity.

The practical aspect of these investigations from the point of view of the South Indian ryot is that the relationship of green manure to the aeration of roots is of the greatest importance and that, apart from all other considerations of manurial value or its influence on the texture of soil, one of the most important functions of green manuring with reference to paddy soils lies in promoting the activity of the surface film which is responsible for the proper aeration of the roots. We have also learnt that green manuring does not always give good results on all soils and that when drainage is deficient, the toxins produced during the decomposition of the green manure affect the growth of the crop adversely and that, therefore, green manuring should not be adopted as a universal practice but should be undertaken after careful consideration. The universal practice of puddling paddy soils has been understood and this knowledge has led to the conclusion that drainage can be controlled by means of puddling and that this is easily at the command of the ryot.

Another very important practical indication of these investigations is that growing a green manure crop in a field to which it has to be subsequently applied as green manure, is not advantageous as the nitrogen is largely dissipated as gas and as the crop had taken its nitrogen originally from the soil, it involves a distinct loss of nitrogen.

The work on paddy soils and the nutrition of the paddy plant has so far been considered. The work on the dietetic value of rice which forms the main food of a large section of the people of South India will now be considered. This investigation has its origin in a collaborative work of the chemical section with the Deficiency Diseases Inquiry into the relationship existing between rice and Beri-beri in India.

The problem of the relationship of rice to Beri-beri will not be specifically discussed here but certain aspests of the defects of polished white rice will be briefly considered.

Fashion is so contagious that even the poorest man is anxious to use higbly-polished spotless white rice if he could only secure it. It is no exaggeration to state that the opulence and the extent of refinement of a man is partly measured by the quality of the rice he uses. Little do we know what valuable nutrient materials are lost in the polishing. The greater the polish, the greater is the loss. The fats, proteins, mineral salts and vitamins are stored in the outer dirty brown or red coating of the rice grain, and during the process of polishing these nutritive constituents are lost and all that remains is mostly starch.

Analyses in the laboratory and feeding trials with pigeons have shown that raw-milled, unpolished rice is the most nutritious, while raw-milled, highly-polished rice is the least nutritious. Parboiled rice comes midway between these two extremes. Parboiled and milled rice, in the unpolished stage, is not so nutritious as raw-milled and unpolished rice; but even when it is polished, boiled rice possesses a higher nutritive value than the corresponding raw polished rice.

Washing of rice just before cooking has also been found to deprive rice of a good deal of its most nutritious ingredients. The effect of draining rice after cooking should also be similar.

EMPIRE SPICES

THEIR PRODUCTION AND IMPORTANCE*

SPICES, like vitamins, might well be described as "accessory food factors." Although, generally speaking, devoid of any nutritive value, their judicious use serves to render food more palatable and to stimulate the digestive powers. In virtue of the essential oils which they contain, many spices exercise a useful carminative action and, moreover, possess valuable antiseptic powers.

Outside the industries in which spices are employed, their importance is perhaps, not as fully realised as might be desired. Apart from their use in the culinary arts, spices find many useful applications in the perfumery industry. Many are employed medicinally, whilst from some of them, valuable chemical products are obtained. In connection with this last application an extremely interesting and very important process, in which what is practically tantamount to the conversion of one spice into another is effected, calls for special mention. From the essential oil obtained from cloves a substance known as "eugenol" is isolated which, *by appropriate chemical means, is converted into vanillin, identical in* every way with vanillin obtained from vanilla pods, which is the chief odorous constituent of this spice. The process, which is essentially an English one, is also applicable to the essential oil of cinnamon leaf, and the vanillin manufactured by it is generally regarded as being superior to vanillin made on the Continent by a different process from guaiacol.

One naturally associates the cultivation of spices with the flowery and aromatic East. Whilst, however, the contribution of Asia to the spice markets of the world is very considerable, there are many important centres of spice production eleswhere. The British Empire is rich in spice-producing lands, and, in addition to India and Ceylon, mention must be made of Zanzibar, Sierra Leone, Seychelles and the British West Indies as important spice-producing colonies.

The Moluccas or Spice Islands, the home of both the clove and the nutmeg, were discovered by the Portuguese in the sixteenth century and in 1619 passed into the hands of the Dutch, who, in order to keep up prices, did all in their power to limit production. A similar policy was adopted by them in Ceylon, which at one time was the only country producing cinnamon, all excess of the spice over a certain stipulated amount per annum being burnt.

Naturally such a short-sighted policy could not continue unchallenged or for long persist. In the eighteenth century, the French were successful in smashing the clove monopoly, the spice being successfully introduced and cultivated in Mauritius. In the case of cinnamon, Ceylon passing into the possession of the British the spice remained a monopoly of the East India Company until 1833.

Cinnamon.—In any account of Empire spices, pride of place must, perhaps, be given to cinnamon, as being almost exclusively an Empire product. The spice consists of the dried bark or shoots of the Ceylon cinnamon tree, *Cinnamomum-zeylanicum.* There are other species of *Cinnamomum* trees possessing aromatic barks used as spices, chief of which are Chinese cinnamon or cassia, *Cinnamomum cassia,* and Javanese cinnamon, *Cinnamomum burmanni.* These, however, are quite

* By H. Stanley Redgrove, B. Sc., A.I.C. in ***Empire Production and Export,*** No. 158, October, 1929.

distinct from true cinnamon, both in flavour and other respects, and are less highly esteemed.

When growing wild, the Ceylon cinnamon tree has been known to attain a height of as much as 40 feet, but under cultivation it exists as a coppiced shrub. As already mentioned, its native home is Ceylon, which is the country where it is chiefly cultivated. It is also found in Southern India, and has been introduced into the Seychelles; but trees grown in the last-mentioned colony produce a spice inferior in flavour to those grown in Ceylon, and yield an essential oil of a very different character.

The essential oil of cinnamon bark is obtained by distilling the bark with water or steam, and is highly valued in perfumery for its delicious odour. It is also used as a flavouring agent and as drug. Oil distilled in England or on the Continent compares favourably with that distilled locally in Ceylon, as the latter is so often adulterated with oil obtained from cinnamon leaves. There would seem to be an opening for enterprise here, since, with modern plant operated under stringent conditions, it should be possible to produce locally an equal to that distilled in England and at a much lower cost.

The essential oil of cinnamon leaf, which is very unlike cinnamon bark oil and more closely approximates in character to clove oil, is, as already mentioned, an important source for the isolation of eugenol, from which vanillin is manufactured.

The following figures relating to the exports of cinnamon and cinnamon oils for the year 1928 will be of interest, as indicating the magnitude of the trade in these commodities. Ceylon: Cinnamon quills, 34,699 cwt.; cinnamon chips (used mainly for distillation), 11,114 cwt.; cinnamon bark oil, 9,122 lb.; cinnamon leaf oil, 36,397 lb. The quantity of cinnamon quills shows some increase over the amounts for preceding years, but the figures for the oils indicate a big drop. Seychelles: Cinnamon, 2,120 cwt.; cinnamon bark oil, 68 lb.; cinnamon leaf oil, 138,812 lb.; the exportations of cinnamon and cinnamon leaf oil both being on the upgrade. So far as India is concerned, the amounts exported are inconsiderable, the figures for the year ended March 31st being: Cinnamon, 49 cwt.; and cinnamon oil (nature unspecified), 310 lb.

Nutmegs and Mace.—It is, perhaps, not generally known that nutmegs and mace are products of one and the same tree, but such is the case. The tree in question, *Myristica fragrans*, is a native of certain of the Spice Islands, and was introduced into Ceylon in the early part of the nineteenth century. It is cultivated nowadays in a number of tropical countries, including the British West Indies, especially Grenada, which exported, in 1927, 21,238 cwt. of nutmegs and 3,733, cwt. of mace.

The nutmeg tree produces a fruit somewhat resembling a large apricot in appearance and colour. When ripe, the husk splits open, disclosing a glossy, dark-brown nut, enclosed in a peculiar netlike covering, or aril, which is of a scarlet colour.

The nuts and arils are separately dried. The dried aril constitutes mace; and the hard brown seeds, which are easily removed from the nuts, whose shells are thin and brittle, form the nutmegs of the shops. Before exportation, the nutmegs are often treated with lime as a preservative against the attacks of insects. They are graded according to size and condition, good specimens being sold as a spice whilst inferior ones may be sold as a ground spice or used for manufacturing either the distilled or expressed oil of nutmegs. The first is obtained by distilling the ground nutmegs with steam, and it is interesting to note, is much employed as a flavouring agent in the manufacture of dental creams and in the tobacco industry. The expressed oil, which is a solid fat, often erroneously called "oil of mace," is obtained by subjecting the nutmegs to hot pressure.

Cloves.—Turning our attention to cloves, this spice consists of the dried, unopened flower-buds of an evergreen tree, ***Eugenia caryophyllata*** a native of certain of the Molucca Islands, and as already indicated at one time only obtainable from this part of the world. Cloves have been and still are cultivated in many countries. For a period, Penang produced what were usually regarded as the finest cloves obtainable; but the cultivation of the clove in Malaya, which is in the hands of the Chinese, has sadly declined in recent years, and Malaya can no longer be seriously considered as one of the important clove-producing colonies.

On the other hand, clove-production in Zanzibar has made very satisfactory progress. In 1927, Zanzibar exported 249,453 cwt. of cloves and 49,209 cwt. of clove stems, as compared with 183,624 cwt. of cloves and 22,491 cwt. of clove stems for 1922. Cloves are also cultivated in Ceylon and India, but the amounts exported are quite inconsiderable. It is estimated that Zanzibar and the adjacent island of Pemba produce about nine-tenths of the world's supply of cloves. The chief foreign competitors are Madagascar (French) and the Dutch East Indies.

Clove trees are usually raised from seed, and require a rich, clayey soil free from damp. Picking the unopened flower-buds and drying them, both call for special care. On distillation with water or steam, they yield an essential oil, which is employed in the perfumery and confectionery trades and is also used medicinally. This oil also provided a source for the isolation of eugenol, to which reference has already been made.

Allspice.—Allspice is another Empire spice of which mention must be made. This is not, as might be thought from its name, a mixture of various spices, but a distinct spice, better called "pimento." It consists of the dried unripe berries of a small tree, *Pimenta officinalis*, which is a native of the West Indies and Central America. The name "allspice" is given to it because the flavour is supposed to resemble that of a mixture of cinnamon, nutmegs, and cloves. Jamaica, the chief producing centre in the British West Indies, exported 88,075 cwt. of this important spice in 1927.

Allspice, it may be noted, on distillation with water or steam, yields an essential oil, which is used to some extent in soap perfumery and in preparation of bay rum. The leaves of the plant also yield an oil when similarly treated. Both oils contain a considerable amount of eugenol.

Ginger.—No account of Empire spices would be complete without reference to ginger. This spice consists of the underground rhizomes of an herbaceous perennial, ***Zingiber officinale***, which is a native of Tropical Asia, but is cultivated in many tropical countries, including so far as the British Empire is concerned, Jamaica and Sierra Leone, in addition to India where it has been grown for centuries. Ginger comes on the market in two main forms, peeled and unpeeled, of which the first is the more highly esteemed. The rhizomes are dug up after the aerial parts of the plant have dried in the sun, or, in the case of peeled ginger are washed, peeled with a narrow-bladed knife, washed again, and finally dried. Sometimes the ginger is parboiled before peeling. Jamaica ginger is usually peeled and the amount exported in 1927 was 24,905 cwt. being rather less than that for 1926, but in excess of amounts for preceding years. Until recently ginger from Sierra Leone was only roughly scraped, but a better quality peeled ginger is now exported by this colony and has been well received, not only in Great Britain, but also in the United States, Canada, and South Africa. The amounts exported show a steady increase up to 1926 (55,265 cwt.), but in 1927 the amount fell to 27,354 cwt. India also exports a very considerable quantity of ginger, the amount for the year ended March 31st, 1928, being 33,126 cwt.

The uses of ginger in the confectionery trade and also as a medicine are too well known to need more than bare mention. It may be added that, in addition to being, like other spices, a useful carminative, ginger is by no means devoid of nutritive value, as it contains a considerable proportion of starch.

Pepper.—Pepper, again, is another extremely important spice which is produced in the British Empire. Pepper is the berry of a vine-like climbing plant indigenous to the moist, low-country forests of Ceylon, South India and Malaya, and is extensively cultivated in India by both natives and Europeans, the amount exported by British India for the year ended March 31st, 1929, being 92,465 cwt. rather less than half that exported during the previous year. The plant thrives best in a hot, moist climate where there is a plentiful rainfall, and the trade in pepper is probably one of the oldest branches of commerce between Europe and the East. Certainly during the Middle Ages it was one of the most important.

The two main varieties of pepper, white and black, are both produced from the same plant, *Piper nigrum*, the difference arising from the stage at which the berries are plucked and the manner in which they are afterwards treated. Black pepper, which is the sort chiefly produced in India, is obtained by collecting the berries before they are completely ripe and drying them in the sun. White pepper, on the other hand, is obtained by soaking the ripe berries in water to bring about fermentation, after which the pulp is removed, a process usually effected by trampling the mass under feet. The fruits are then dried. White pepper is less pungent in flavour than the black variety.

It should, perhaps, be mentioned that long pepper, which is quite distinct from these, although somewhat similar to black pepper in taste and odour, is obtained from other species of pepper plant, especially *Piper officinarum*, cultivated in Java (Dutch).

In addition to those already dealt with, otber spices are produced within the British Empire such as chillies, turmeric and cardamoms in India; vanilla, in very small amounts, in Dominica and Seychelles, as well as some others of less importance, about which considerations of space forbid details being given. Enough has been said, however, to indicate the position of first-class importance the British Empire occupies in the matter of spice production. Whilst that position can be viewed with pride, this is not to say that there is no room for improvement or further advancement. The possibilities of India as a spice-producing country have by no means been fully exploited; and, on the face of it, there seems to be no adequate reason why vanilla, the flavour of which is preferred for many purposes to that of artificially produced vanillin, should not be successfully cultivated on a large scale in the British West Indies.

WATER-AND-OIL TREATMENT AGAINST SOIL-INHABITING TERMITES AND ANTS*

PHILIPPINE termites of the genera *Coptotermes, Heterotermes, Termes*, and occasionally certain other forms, which build their nests under the ground, are injurious to posts and other wooden structures that are set in the soil or otherwise come in direct contact with it. There are also frequent cases of these ground-inhabiting termites laying their tunnels along cement walls of concrete buildings in order to reach the wooden floors and framework in the superstructure. The preventive measures recommended by various authors, namely, that of using metal strips or shields on concrete bases to isolate the upper wooden parts of buildings from the ground probably constitute the best and most dependable method of protection against subterranean termites; but unfortunately the practice is not feasible for general adoption in the Philippines. It would be applicable only in the case of the more expensive permanent structures. In houses in the average *Barrio* community, the primary consideration is cheapness, and the component parts are largely such short-lasting materials as bamboo, nipa, and rattan. Quite frequently, these buildings are very temporary affairs, and the owner cannot afford to set his posts on concrete foundations and put on extra appurtenances in the form of metal strips or shields. When the termites attack the posts or other parts of the building, as they invariably do, the damaged parts are replaced. More or less extensive repairs of this nature usually have to be made once a year or oftener.

Under such ideal conditions for termite attack wherein the stage is always set for infestation, damage may still be prevented or at least minimized by making regular and frequent inspection of the parts of the buildings in contact with the ground and promptly employing proper remedial measures. Ground-inhabiting termites betray their presence by the conspicuous tunnels of earth and other dark-coloured materials that they construct to cover their exposed runways on objects above the surface of the soil.

Paris green has in recent years come into vogue in connection with the control, both of subterranean and of wood-inhabiting termites in parts of the United States, Porto Rico and elsewhere. Paris green is placed along the runways of termites so that in their march some of the poisonous dust will adhere to the insects' legs and bodies. The idea is to take advantage of the termites' habit of licking one another's body, whereby they thus eat some of the adhering particles of the poison. The result is that even the young nymphs and the queen in the nest would ultimately be poisoned by the workers when they return home. The writer has made but limited trials of this method of control; the results have been either fair or indifferent. Possibly by following the recommendation of Smith of scattering the dust in the termite runways with a De Vilbiss atomizer No. 79 better results could have been obtained. It is intended to follow the work up in our laboratory.

During the past two years another method has been used by us in ridding the building which houses the Departments of Entomology and Plant Pathology, of underground termites which from time to time build

* From *The Philippine Agriculturist*, Vol. XIX, No. 9, 1931.

their tunnels up along the concrete walls to the wooden parts above. One of these species, which invaded the building in June, 1929, was *Coptotermes vastator* Light, a very destructive and not easily controlled pest. Repeated trials to locate the nest of that particular colony had failed, we had dug up the ground for a depth of one and one-half meters along the base of the wall where the tunnels had their connection, but without success. We had tried the Paris green method, we had fumigated the soil with a copious supply of calcium cyanide granules, but all to no avail. The other infestations were by species of *Termes* two of which occurred on the wooden posts of the garage which were set in the ground and the rest in the building proper, as in *Coptotermes*.

The procedure we finally adopted was as follows: A shallow trench was dug in the soil where the termite tunnels were connected. This was then filled with water until the soil was so thoroughly drenched that absorption became very slow. If the place was near a faucet, a rubber hose was used; otherwise water was carried in pails. Enough waste engine oil (such as that drained from the crankcase of motor cars) or kerosene was then poured into the trench to make a very thick film on the surface of the water. As the water soaked downward, the oil was drawn by surface tension under the ground and through the communication galleries of the termites into the nest. Previous trials with oil alone, without water, had failed because the oil did not penetrate into the soil well enough to reach the main termite colonies, and, beside the fact that more oil had to be used, the treatment resulted in merely shifting the direction of march of the ravagers.

In our trials with this method, both in the use of *Termes* and the persistent *Coptotermes* one treatment was found sufficient to destroy an entire colony. The day following the operation, tunnels were sometimes seen rebuilt on the walls, either partly or wholly, in their original location; but these were the work of the workers that had been caught in the upper parts of the building during the treatment and shut off from their nests by the oil. In some cases these tunnels continued to be rebuilt for two or three days, but after this period the last remaining representatives of the colony disappeared. Nests of *Termes* that were dug out a few days after treatment were found to contain only dead individuals. There has not been a single case or recurrence of infestation from the same source following each treatment.

The simplicity of the method, the ease in obtaining the materials used and at little or no cost, and its efficacy against subterranean termites are among its desirable features. The practice has been found to work with equal success on ground-inhabiting species of ants which are a frequent nuisance around houses and yards. When treating ants' nests, however, it was found unnecessary (and also decidedly inconvenient) to dig a trench. The ground in which the openings of the nests were located was merely soaked thoroughly with water before oil was added. More water was then poured so as to give the oil better distribution. Several coconut-shellfuls of water and a few tablespoonfuls of oil are all that are needed for treating an average ant's nest. Because of the injurious nature of mineral oils, the method should not, of course, be used if the nests are located at the bases of tree trunks or other valuable plants.

COFFEE CULTIVATION IN JAVA*

IN the eighteenth century and in the first half of the nineteenth century "Java coffee" (*Coffea arabica*) was cultivated on a large scale by the natives under the pressure of the Government. After 1870 this culture was also started by private people and companies working with European capital, and East Java became the centre of coffee growing in the Dutch East Indies.

This flourishing industry was brought to an end by the leaf disease (*Hemileia vastatrix*) which made its appearance in 1876 and quickly spread over the whole Archipelago. At present "Java Coffee" (*Coffea arabica*) is only to be found on some estates high up the mountains and is cultivated by the natives in some parts of the other islands (Bali, Sumatra, Celebes, Flores, Timor). At that time newly-imported Liberian coffee (*Coffea liberica*) seemed less susceptible to the leaf disease and was planted to a certain extent, but after a few years it began to be more and more attacked and at last it was also greatly devastated.

On many estates where arabica and liberica were cultivated next to each other, cross fertilisation took place and in the nurseries hybrids appeared among the seedlings. One of these, originated at the plantation "Kawisari," was especially considered worth cultivating and at present this hybrid is cultivated on a fairly large scale on different estates. It is a remarkable fact that this hybrid, originated from parents both very liable to leaf disease, is resistant.

The salvation of the coffee industry was the importation in 1900 of the "robusta coffee." This species proved to be very suitable for the conditions in the Dutch East Indies and it is at present one of the most important crop plants, both for the estates and for the natives. In 1927 and 1928 each of these two groups produced about 60,000 tons of coffee. The following figures show the export of the three kinds of coffee from the Netherlands Indies, grown on estates and by natives.

Coffee exports from the Netherlands Indies, in tons of 1000 kg.

	Estates			Native Farms			Total
	Arabica	Liberica	Robusta	Arabica	Liberica	Robusta	
1927	1000	800	62,000	6000	—	51,000	121,000
1928	900	600	52,000	6000	—	65,000	126,000

No figures are available as to the area of native coffee planted; the area under coffee on the estates amounted in 1925, 1926, and 1927 respectively to 116,530, 117,351, and 118,445 hectares. Of the area planted in 1927—69,311 hectares were not interplanted and 49,134 interplanted. With other crop trees Java had 95,042 hectares (the greater part, viz. 77,136 hectares in East Java) and Sumatra 21,032 hectares; only a couple of thousand hectares in the other islands. As regards the areas planted with each of the different kinds of coffee, 107,992 hectares were under robusta, 4,812 under arabica and 4,164 under liberica and a small area under other kinds of coffee.

* From *International Review of Agriculture*, Part 1, Year XXI, No. 10, 1930.

As regards disease and pests, robusta is not immune against leaf disease but it suffers little from it and its predisposition has not become greater in the course of the years as was the case with the liberica. More trouble is experienced from a small beetle, that bores into the berries and destroys the contents (*Stephanoderes hampei*). It has been introduced with coffee seeds from Africa. This pest is combated by harvesting at short intervals in order to remove the breeding places as soon as possible, and by keeping the soil clear of fallen coffee berries. In East Java where the crop is limited to a certain number of months and picking does not take place the whole year through, a further effective means of combating the borer is the removal after the crop of all berries still left over from blossomings of the year previous to the crop year. Besides the Government Institute for Plant Diseases imported from Africa a parasite wasp. This has been bred and distributed to the plantations, but up till now the wasp has not proved to be of much use.

In this and in many other problems much use has been derived from the co-operative efforts of the scientist and the practical planter. The scientific work is done by the staff of the Coffee Experiment Station, Malang, and the experiments on the plantations are done in close collaboration with the planter. Formerly it could be said that the planters merely followed in their fathers' foot steps but now they accept the advice of the scientists.

Owing to the practising of scientific methods in orchard work and on account of its cheap labour Netherlands Indies is, as regards coffee culture, in a strong position and may regard its future with equanimity.

One of the important measures which have reduced the cost price by increasing the production has been the use of green manures.

By a judicial use of shade trees the damage caused by heavy winds and also that caused by long droughts—as often occur in East Java—is avoided.

Improvement of the planting material is obtained by using seed of trees which excel in production and in other favourable characteristics, such as large-sized berries, and by this measure the present robusta trees are, taken as a whole, superior to those originally imported.

Robusta coffee is exported primarily to Holland—for more than one-fourth of the total—while almost as much is shipped to France. The United States, Singapore, and Spain are also important purchasers.

Of the native coffee industries in the Dutch East Indies, that of the island of Bali is very interesting. *Coffea arabica* is mostly cultivated, a small area is devoted to robusta coffee. The arabica culture began to get important in the middle of the nineteenth century. At present the exports amount to a yearly average of 2,000 tons. In consecutive years the yield varies much, as is always the case with arabica coffee; it varies from 1,400 to 2,800 tons. The native farms vary in size from 1 acre to 20 acres, a few have a larger area in coffee. One of the remarkable features of this native coffee industry is the judicious use of shade trees. While in other parts of the Netherlands Indies and in fact in many other coffee-growing countries natives generally dispense with shade trees—a system which gives on good soils, high yields during three or four years but a quick decline of the coffee after its fifth or sixth year—the Balinese people cultivate their coffee under dense shade of the "dadap" (*Erythrina lithosperma*). They are so convinced of the beneficial effect of the shade tree on the soil, that they plant the dadap on new land a few years before the coffee is planted, thus improving the soil beforehand.

When the coffee goes backward, the Balinese rejuvenate the fields by bending down the coffee trees and inducing them to make new watershoots; some of these at the base of the tree are left for making new stems and the old stem is cut down.

THE FOREIGN TRADE OF THE UNITED STATES OF AMERICA IN TEA IN 1930*

ANALYSIS OF STATISTICS COVERING IMPORTS AND RE-EXPORTS OF TEA

EACH year the important figures covering tea purchased by the United States from foreign lands tell the same story—stationary or decreased shipments and a consequent slight decrease in *per capita* consumption. The year 1930 was no exception to the rule. Tea imports totalled only 84,926,000 pounds as against 89,373,000 pounds in 1929. The total value of this trade fell off in about the same proportions, being $22,595,000 for the year just closed as compared with $25,866,000 for the year before.

This decrease, however, is entirely in the teas from Far Eastern sources. Those from the British Indies, both direct and transhipped through Great Britain and Canada, showed a fair gain in total volume, although lower prices brought the value down below that of 1929 except in the case of the comparatively unimportant transhipments through Canada.

Japan Relinquishes First Place.—Perhaps the most notable change in the trade last year was the relinquishment of first place among our foreign suppliers by Japan. That country has led all others for an indefinite number of years, and in 1929 it still maintained its position with total shipments to this country of 24,539,000 pounds. In 1930 this total fell to 20,948,000 pounds and was passed by that of the tea coming from Great Britain, which amounted to 22,830,000 pounds, nearly a million pounds more than in 1929. Shipments direct from Ceylon stood at 17,986,000 pounds having a value of $5,768,000 in 1930, a small increase in amount and a decrease in value from 1929. India's direct contributions also gained slightly, rising from 8,788,000 pounds valued at $2,530,000 to 9,506,000 pounds valued at $2,382,000 in 1930.

China Imports Drop 33%.—Tea imports from China continued their history of recent years by taking a sharp drop of some 33 per cent., the trade in 1930 totalling only 6,467,000 pounds as against a figure of 9,467,000 pounds in the preceding year. The value declined even more and fell below $1,000,000, the total of $975,000 comparing with $1,751,000 in 1929, a drop of almost 50 per cent. Tea from the Netherlands East Indies showed the same downward tendency, although the falling off from 5,051,000 pounds in 1929 to 4,766,000 pounds last year was comparatively small.

Including teas shipped through Canada and Great Britain, the total teas coming to the United States from British plantations in the East Indies amounted in 1930 to 50,811,000 pounds, having a total value of $16,179,000. This represented 60 per cent. of the total imports in point of volume, and about 70 per cent. in point of value.

Re-exports of tea, covering a multitude of small shipments to a large number of foreign countries but principally to Latin America, were 609,000 pounds in 1930, valued at $208,000—a fair gain over the 1929 trade in volume but a decrease in value.

* From *The Spice Mill,* Vol. 54, No. 2, 1931.

TEA IMPORTS

		1929	
		Lb.	Value
United Kingdom	...	21,923,137	$8,162,020
Canada	...	412,780	211,717
British India	...	8,787,873	2,529,784
Ceylon	...	17,534,645	6,209,054
China and Hongkong	...	9,467,287	1,751,223
Netherlands East Indies	...	5,050,898	1,390,622
Japan	...	24,538,932	5,151,753
Other Countries	...	1,657,622	459,916
Total	...	89,373,174	25,866,089

		1930	
		Lb.	Value
United Kingdom	...	22,830,219	$7,809,157
Canada	...	489,497	219,897
British India	...	9,505,904	2,381,719
Ceylon	...	17,985,589	5,767,818
China and Hongkong	...	6,467,403	975,421
Netherlands East Indies	...	4,765,751	1,110,698
Japan	...	20,948,428	3,896,722
Other Countries	...	1,933,429	433,213
Total	...	84,926,220	22,594,645

TEA RE-EXPORTS

	1929		1930	
	Lb.	Value	Lb.	Value
Italy	...	...	75,020	$11,276
Canada	51,100	$20,270	32,398	11,106
Panama	87,205	30,430	69,893	24,930
Mexico	58,052	27,776	44,064	22,065
United Kingdom	42,022	11,058	116,759	28,534
Peru	74,615	35,026	54,990	21,979
Hongkong	7,143	1,832	52,017	11,850
Other Countries	217,556	95,359	164,105	76,312
Total	537,693	221,751	609,246	208,052

COCONUT STATISTICS OF MALAYA*

AREA IN 1930

	State or Territory	IMMATURE		Total Immature area (acres)	MATURE		Total mature area (acres)	Total (acres)
		On holdings of			On holdings of			
		Over 100 acres each	Under 100 acres each		Over 100 acres each	Under 100 acres each		
Federated Malay States	Perak	11,476	14,196	25,672	37,664	45,604	83,268	108,940
	Selangor	5,398	35,519	40,917	32,429	36,948	69,377	110,294
	Negri Sembilan	155	1,121	1,276	914	3,776	4,690	5,966
	Pahang	256	3,948	4,204	2,456	7,870	10,326	14,530
	Total F. M. S.	17,285	54,784	72,069	73,463	94,198	167,661	239,730
Straits Settlements	Singapore	—	—	—	3,159	4,841	8,000	8,000
	Malacca	—	2,330	2,330	—	10,255	10,255	12,585
	Dindings	893	1,696	2,589	1,764	2,177	3,941	6,530
	Province Wellesley	2,183	1,438	3,621	15,415	17,785	33,200	36,821
	Penang	308	359	667	2,936	9,923	12,859	13,526
	Labuan	—	1,958	1,958	—	1,238	1,238	3,196
	Brunei	—	681	681	—	689	689	1,370
	Christmas Island	—	—	—	—	19	19	19
	Total S. S.	3,384	8,462	11,846	23,274	46,927	70,201	82,047
Unfederated Malay States	Johore	428	32,622	33,050	2,873	129,127	132,000	165,050
	Kedah	361	8,453	8,814	492	17,382	17,874	26,688
	Perlis	—	1,434	1,434	—	2,527	2,527	3,961
	Kelantan	—	—	—	—	—	—	57,271
	Trengganu	—	—	—	—	—	—	25,000
	Total U. M. S.	—	—	—	—	—	—	277,970
Grand Total	Malaya							599,747

* From *The Malayan Agricultural Journal* Vol. XIX, No. 2, 1931.

THE FOLLOWING ARE THE FIGURES OF THE 1924 CENSUS IN MALAYA

Federated Malay States		Straits Settlements		Unfederated Malay States	
Perak ...	75,281 acres	Singapore ...	6,565 acres	Johore ...	92,500 acres
Selangor ...	62,117 „	Malacca ...	45,000 „	Kedah ...	27,550 „
Negri Sembilan ...	6,604 „	Dindings ...	6,000 „	Kelantan ..	70,900 „
Pahang ...	19,400 „	Province Wellesley ...	55,000 „	Trengganu ...	8,000 „
		Penang ...	15,000 „	Perlis ..	2,578 „
Total F. M. S.	163,402 acres	Total S. S.	127,565 acres	Total U. M. S.	201,528 acres
		Total Malaya 492,495 acres			

MEETINGS, CONFERENCES, ETC.

BOARD OF AGRICULTURE

ESTATE PRODUCTS COMMITTEE

Minutes of the Forty-ninth Meeting of the Estate Products Committee of the Board of Agriculture held at the Head Office of the Department of Agriculture at 2-30 p.m. on Tuesday, March 10th, 1931.

Present.—The Director of Agriculture (*Chairman*), the Director of the Tea Research Institute, the Chief Technical Officer of the Rubber Research Scheme, the Entomologist, the Agricultural Chemist, the Acting Mycologist, Sir Solomon Dias Bandaranaike, Messrs. N. D. S. Silva, C. A. M. de Silva, C. Rasanayagam, E. C. Villiers, H. D. Garrick, J. B. Coles, R. G. Coombe, J. Horsfall, S. Pararajasingham, F. R. Dias, C. Drieberg, L. F. Roundell, A. W. Warburton-Gray, J. Forbes, A. H. Reid, J. W. Ferguson, C. C. du Pré Moore, Gordon Pyper, R. Murdoch, R. P. Gaddum, C. Bourchier, F. A. E. Price, F. H. Griffith, G. B. Foote, G. Pandithesekere, and T. H. Holland. (*Secretary*).

Visitors.—Dr. C. H. Gadd, Messrs. E. J. Livera, V. Canagaratnam, N. D. Simpson, C. N. E. J. de Mel, J. Carson-Parker, R. Smerdon, G. Harbord, and Lt.-Col. K. D. H. Gwynn.

Letters or telegrams of regret of inability to attend were received from Sir Marcus Fernando, Mudaliyar S. M. P. Vanderkoen, Messrs. H. L. de Mel, L. G. Byatt, J. P. Blackmore, A. W. Ruxton, J. H. Titterington, B. M. Selwyn J. Sheridan-Patterson, Wase de Niese, G. Robert de Zoysa, and C. H. Wilkinson.

Members had been notified before the meeting that items four and eight were to be deleted from the agenda.

Before starting the business of the meeting, the Chairman alluded to the fact that no meeting had been held since July 1930, owing to lack of agenda. He attributed this partly to the prevailing depression and partly to the existence of Research Institutes for tea, rubber, and coconuts, to which problems on these crops were now often referred. In addition there had been a good deal of excitement over matters of taxation, and this was not conducive to an atmosphere of calm deliberation of agricultural problems. He proposed discussing the question of future meetings at the end of the agenda.

The Chairman then alluded to the question of tea tortrix returns. These returns were not in all cases coming in satisfactorily and he desired an expression of opinion from the tea industry as to the desirability of continuing these returns. He thought the returns had been useful in the past and might continue to be so. He proposed to refer to this question again at the end of the meeting.

The Chairman then touched on the future work of the Experiment Station, Peradeniya. A good deal of work had formerly been carried out by the Department which could now legitimately be referred to the Research Institutes for tea, rubber, and coconuts. Referring to rubber he pointed out that a considerable number of experiments were to be continued in the old rubber areas, while on the Iriyagama Division the work of testing Ceylon mother trees and certain imported clones was in progress. He

briefly alluded to the problems of the rubber industry and the directions from which an improvement could be looked for. The question of the study of new crops such as tung oil, chaulmoogra oil, croton oil, coffee, citrus fruits, etc. was assuming increasing importance. These crops were receiving attention on the Experiment Station and the Department was always ready to give any possible advice and help on such crops. With regard to tea, it was not intended entirely to abandon experimental work. The tea area was only twenty-one acres in extent and being somewhat steep, rocky and uneven was not suited to manurial and similar experiments. The land was suitable for pruning experiments. He proposed to discuss the question further at the end of the meeting. As regards coconuts very little work had been undertaken on the station but he hoped that the Coconut Research Scheme would soon be in a position to initiate experiments. The acquisition of the estate had been completed and the question of the erection of laboratories was now being considered.

AGENDA ITEM 1. CONFIRMATION OF MINUTES

The minutes of the last meeting, having been circulated to members, were taken as read and confirmed.

AGENDA ITEM 2. PROGRESS REPORTS OF THE EXPERIMENT STATION, PERADENIYA

Reports for July and August 1930, September and October 1930, November and December 1930, and January and February 1931 were in the hands of members. The Chairman invited comments on these reports.

Mr. Foote expressed concern at the proposed reduction in rubber experimentation in view of the fact that the Rubber Research Scheme had at present no opportunities for experimentation. He enquired the date of commencement and period of duration of the rejuvenation experiment as originally planned. He enquired further whether figures were available of the incidence of brown bast in the change-over experiment.

Mr. Holland explained that the cutting out of rubber proposed would result on the old experimental area in a reduction of the area under this crop to 38 acres, and that except for the rejuvenation experiment no experiment was being cut short. The area under the rejuvenation experiment was divided into four plots—according to the original plan, plot 1 was to be tapped to death in one year, plot 2 in two years, plot 3 in three years and plot 4 in four years. The experiment was started on September 1st, 1929. Only the tapping of plot 4 would be cut short and he considered that ample information as to the results of the method of tapping employed in that plot would be available in three years. The idea of re-planting was abandoned but he did not consider the area suitable for this purpose as the number of trees per acre was irregular and small. Figures of brown bast incidence in the change-over experiment could be made available and he promised to furnish these.

Mr. Foote remarked that it was proposed also to cut out the rubber in plots 151-154.

Mr. Holland said that this was the poorest rubber on the station and that even when this block was cut out there would still be 38 acres left.

Mr. Foote, in alluding to the yields of budded rubber in plot 165, remarked on a statement in the report that it had been stated in the F.M.S. that when the tapping cut was approaching the point of union of stock and scion the yield of latex was negligible. He enquired if there was any scientific explanation to support this statement.

Mr. Holland replied that he believed he had taken the statement from Summers' book. He agreed with Mr. Foote that the yields in plot 165 did not appear to confirm the theory.

The Chairman remarked that a great deal was still to be learnt about the junction of stock and scion and the influence of the one on the other.

Mr. Foote then alluded to a theory that the upward growth of the stock resulted in the junction of stock and scion being raised to a greater height than at the time of budding, and that budding should be done below ground level.

Mr. Holland said that the trees in plot 165 did not bear out such a theory, the lower end of the sloping line of junction was in most cases near the ground level. He remarked that the ground level often altered.

Mr. O'Brien said that there was no support for the theory that the point of junction would be raised to any extent by the upward growth of the stock.

In connection with rubber experiments, at the Chairman's request, Mr. Holland outlined an experiment which it was intended to carry out on the Iriyagama Division on some trees which could not be included in an area for testing of clones. This was to bud a number of known stocks high up with buds from proved clones and subsequently to tap both stock and scion with the object of noting whether the scion influenced the yield of the stock.

Dr. Norris enquired the probable date of publication of the Manual of Green Manuring which had been alluded to in one of the progress reports.

The Chairman replied he was afraid there must be delay on account of work in preparation for the New Constitution at the Government Press. The Manual was ready for the press but he was informed that there was no chance of getting it printed till after April.

Mr. E. C. Villiers enquired if, in view of the congestion in the Governmenr Printing Office, the Manual could not be printed by a private press.

The Chairman replied that being a Government publication he was afraid that this could not be done, but it might be possible to first publish the Manual serially in *The Tropical Agriculturist*..

This suggestion, however, was not adopted by the meeting.

Mr. Horsfall enquired if it was known at what elevations tung oil trees could be grown in Ceylon.

The Chairman replied that they would grow from sea level to the elevation of Peradeniya but information was lacking as to higher elevations.

Mr. Holland emphasised the necessity of distinguishing between *Aleurites Montana* and *Aleurites Fordii*. The former flourished in a tropical climate but the latter preferred a climate with definite cold season.

AGENDA ITEM 3. PROPOSED INVITATION OF DR. SNYDER TO CEYLON

Mr. R. G. Coombe said that it had been ascertained that Dr. Snyder, the termite expert of the U.S.A. Government, was to visit India in the near future. In view of the serious nature of the damage done by termites, both to agricultural crops and to buildings in this Island, he thought it would be an excellent thing if Government could be approached with a view to obtaining the permission of the Government of the United States for Dr. Snyder's visit to be extended to Ceylon.

Mr. Jepson gave a brief account of the damage now being done by termites which he considered was more serious than was generally realised. Over fifty species of trees were now known to be attacked and the list was growing almost daily. He showed specimens illustrating the damage done by termites.

Mr. Garrick alluded to a case of which he and Mr. Jepson were aware in which the Paris green treatment had been wrongly applied, and suggested that it might be advisable for Mr. Jepson to issue a general warning in the matter.

Mr. Jepson said that in the case alluded to by Mr. Garrick the Paris green had been injected into unattacked bushes with an idea that the injection might prevent attack. In some cases branches so treated had died. The error had been pointed out to the superintendent and he did not think it was likely to recur.

Mr. R. G. Coombe then proposed the following resolution: "That in view of the widespread damage already caused in Ceylon by termites, and the evidence that such damage is likely materially to increase. Government be asked to approach the Government of the United States with a request that Dr. Snyder should be permitted to visit Ceylon before his return to the States to advise regarding termites and their control."

The resolution was seconded by Sir Solomon Dias Bandaranaike and carried *nem con.*

AGENDA ITEM 5. REPORT OF THE SOIL EROSION COMMITTEE.

The Chairman suggested that since the report had only been published a short time and members had not had opportunities for obtaining copies and studying the report, the discussion should be postponed till the next meeting.

This was agreed to.

Some enquiries were made as to the method of obtaining copies of the report and how the findings of the Committee were to be made public.

The Chairman said that the copies of the report could be obtained from the Government Record Office at a cost of Re. 1-10.

Mr. Haigh (Secretary of the Soil Erosion Committee) also mentioned that orders for large numbers of copies had been received by him from the Ceylon Estates Proprietary Association and the Low-Country Products Association, while one firm of agents had ordered six copies. These orders had been passed on to Government.

AGENDA ITEM 6. BLACK BEETLES AND DAMAGE TO COCONUT CROPS

The Chairman said that this item stood in the name of Mr. H. L. de Mel who was unable to be present. Mr. De Mel would doubtless address the next meeting on the subject but meanwhile he desired to make a few remarks as to the current conception that black beetles bred largely in coir fibre dumps. The investigations of the scientific officers of the Department had so far shown that the black beetles did not breed in such dumps. Leaving leafy matter lying about or burying it in shallow trenches might result in the breeding of beetles. Any such material should be buried deep and covered with sand, or soil not rich in humus. He read a short memorandum on the subject of breeding grounds of beetles.

Mr. Warburton-Gray enquired if the Plant Pest Inspector, Kurunegala, had left any notes about the breeding of beetles in buried green manure loppings.

The Chairman said he was not aware of any such notes.

Dr. Hutson said that it had been found that where the stems of the green manure plants were buried, breeding was likely to occur and that *it was advisable to strip off the leaves of the plants before burying.*

Mr. Pandithesekere said that a bad infestation of beetles had occurred when large fibre dumps had been present but when these had been buried, the infestation ceased.

Mr. C. A. M. de Silva supported the view that the beetles bred in coir fibre dumps. He further added that he did not believe in the burial of green coconut leaves, but when calcium cyanamide and ephos phosphate had been added breeding was not found to occur.

Mr. Warburton-Gray said that the beetles did not breed in fibre dumps.

Dr. Hutson said he had recently inspected about ten large fibre dumps in the Madampe district and he definitely asserted that the black beetles were *not* breeding in these dumps. It was possible that a few beetles might sometimes breed on the edges of the dumps. Cockchafer grubs were also sometimes mistaken for the grubs of the black beetle.

The Chairman said he wished to dispel the idea that the black beetle bred in these fibre dumps. The investigations of the scientific officers of the Department showed that this was not ordinarily the case. The presence of beetles should not be taken as evidence that they had bred in coir fibre dumps.

Mr. C. A. M. de Silva pressed for a more rigorous enforcement of the Plant Pest Ordinance in respect of the breeding grounds of black beetles.

The Chairman said that if essential, the Ordinance would be rigorously enforced but he preferred methods which aimed at the education and instruction of coconut growers.

Mr. Pandithesekere said that where road sweepings were buried beetles were always found but they were not found in buried coconut husks.

AGENDA ITEM 7. COTTON CULTIVATION IN ANURADHAPURA AND THE WANNI HATH PATHU AND THE EXTENSION OF COTTON CULTIVATION IN THE DRY ZONE

In the absence of Mr. De Mel, the discussion on this subject was postponed till the next meeting.

Mr. Drieberg read two extracts from the press which tended to create the impression that cotton cultivation could be successfully carried on in the wet zone and suggested that such an impression should be counteracted.

The Chairman said that he took it that only the growing of cotton on a very small scale was referred to and he did not think there was any need to interfere.

AGENDA ITEM 9. DISEASE OF TEA IN NYASALAND

The Chairman said that this question had first been brought up by the American Consul as a result of a report by the American Trade Commissioner in Nyasaland. A copy of this report had been sent to Mr. Leach, the Mycologist in Nyasaland, who reported that unnecessary importance had been given to the matter by the American Trade Commissioner and that there was no cause for alarm. The Mycologist was of the opinion that the disease alluded to existed in Ceylon but was not of any great importance.

Mr. Bertus gave a description of the disease which had already been described as witches broom disease.

Dr. Gadd said that the identification of a disease from a description, particularly a description by a layman, was always difficult. Butler had described the disease in Nyasaland and had thought that it probably existed in the east but it had been confused with *Diplodia*. Dr. Gadd agreed that the disease existed in Ceylon but not that it was confused with *Diplodia*. The disease must be included among the group of diseases known as witches broom disease. Park had first described witches broom disease but stated that it did not spread. The American Trade Commissioner had described a yellowing of the leaves. Dr. Gadd said there was a type which spread but that one was not associated with a yellowing of the leaves. Another type had been described by him as Chlorosis and this type of the disease did not spread.

At the conclusion of the business on the agenda, the Chairman brought up for discussion the question of the number of meetings to be held annually. After some discussion, Mr. Coombe voiced the opinion that the shortage of subject for the agenda had been mainly due to the hard times through which they were passing. He thought that the good attendance and lively interest shown in the day's proceedings indicated that the Committee was very much alive and he deprecated any suggestion of a reduction in the number of meetings. If agenda was lacking meetings could be postponed.

This view met with the approval of the meeting and the suggestion to request the amendment of the Ordinance with a view to a reduction in the number of meetings to be held annually was dropped.

Mr. C. A. M. de Silva suggested that the rule by which a member vacated his seat, if he failed to attend half the meetings held in a year, should be enforced.

The question of tea experimentation at Peradeniya was then discussed.

Mr. Foote suggested the appointment of a small Committee to discuss the matter with the officers of the Tea Research Institute. The Chairman asked Dr. Norris for his views on this suggestion.

Dr. Norris said that he was not aware that the matter was to be brought up and he would prefer to express an opinion at a later date.

It was decided that the matter should be brought up at the next meeting.

The question of tea tortrix returns was then discussed.

Mr. J. W. Ferguson considered that the present mild incidence of tea tortrix was largely due to the collection of egg masses which had had a good effect. He said that the collection undoubtedy increased the cost of plucking and with the present desire for economy there was considerable reluctance to continue collection. He considered however that the discontinuance of the measures in force would be very poor economy and strongly advocated maintaining the present arrangement.

The Chairman hoped that the ventilation of the matter might result in greater interest in the collection of egg masses and regular forwarding of returns.

The meeting then terminated.

T. H. HOLLAND,
Secretary,
Estate Products Committee.

TEA RESEARCH INSTITUTE

MINUTES OF LAST BOARD MEETING

Minutes of a meeting of the Board of the Tea Research Institute, held at the G.O.H., Colombo, on January 29th, 1931.

Present: Mr. R. G. Coombe (Chairman), Hon. the Colonial Treasurer, the Director of Agriculture, Hon. Mr. D. S. Senanayake, Mr. A. G. Baynham (Chairman, P.A. of Ceylon), Major J. W. Oldfield, Major H. Scoble Nicholson, Messrs. J. D. Finch Noyes, John Horsfall, T. B. Panabokke, R. R. Muras (Assistant Secretary), A. W. L. Turner (Secretary), and by invitation Dr. R. V. Norris (Director, T.R.I.), and Mr. J. Carson-Parker (Chairman, Uva P.A.). Messrs. F. F. Roe and Jas. Forbes (Jnr.), were unable to be present.

Before proceeding with the business of the meeting, the Chairman referred to the death of Mr. A. O. Whiting, who was Secretary of the Ceylon Association in London and had done a great deal of work on behalf of the Institute. A vote of condolence was recorded.

Minutes of the meeting of the Board of the Tea Research Institute of Ceylon, held on October 1st, 1930, and of the joint meeting of the Finance sub-Committee, Estate sub-Committee and Experimental sub-Committee held on November 22nd, 1930, were taken as read and confirmed.

The Chairman explained that the statement of accounts as at December 31st, 1930, which had been sent to all members of the Board on January 24th, 1931, was not the final statement for the year, a supplementary account would therefore be issued later.

It was decided that depreciation account be opened forthwith and an annual allowance of 10 per cent. on machinery and 5 per cent. on buildings credited thereto. The accounts were passed without further comment.

The Chairman announced that the increase in Tea Cess was published in the *Government Gazette* on November 14th, 1930.

After discussion and some amendments, the estimates for 1931 were unanimously approved by the Board.

It was decided that the new Government rates should apply to the travelling expenses of members of the Board and Scientific Staff from January 1st, 1931.

Votes of thanks to Messrs. G. R. Whitby and D. S. Cameron for their services as members of the Board were recorded.

The Chairman announced that the new laboratories at St. Coombs Estate were occupied by the staff on December 15th, 1930.

Tbe Cbairman announced that 4 each of the bungalows for the members of the senior and junior scientific staff were now being occupied. A further two junior bungalows would be shortly completed and ready for occupation.

TEAS FOR THE LONDON MARKET

Referring to the resolution passed at the last meeting, the Chairman said that the samples of teas had been sent to London. These had been submitted to nine London firms for valuation and report. Very satisfactory reports had recently been received, indicating that the teas were suitable for the home trade requirements.

SCIENTIFIC STAFF

The Board confirmed the increment due to the Entomologist as from the 9th December, 1930, which had been sanctioned by the Chairman. Reported that Dr. Evans' leave would take effect as from the 11th March, 1931. An application from Dr. Gadd for three months' vacation leave from Ceylon on urgent personal affairs was sanctioned. The Agricultural Chemist's application for 9½ months' leave from the 30th December, 1931, was sanctioned.

The following appointments were announced: Research Assistant, Agricultural Division, Mr. C. A. de Silva; Field Assistant to the Agricultural Chemist, Mr. M. Piyasena; Junior Assistant, Department of Physiology, Mr. O. J. Welaratne.

On the proposal of the Colonial Treasurer the amended rules for the Provident Fund for the subordinate staff were adopted.

The Chairman explained that at present there was a Finance sub-Committee, an Experimental sub-Committee, and an Estate sub-Committee.

He suggested that the Experimental and Estate sub-Committees should be amalgamated and designated the Experimental and Estate sub-Committee. This was agreed to.

The following were elected to serve on these sub-Committees:

Finance sub-Committee: The Chairman, T.R.I., Chairman P.A. of Ceylon, Chairman, C.E.P.A., and Director, T.R.I.

Experimental and Estate sub-Committee: The Chairman, T.R.I., Director, T.R.I., Agricultural Chemist, T.R.I., Visiting Agent, the Superintendent of St. Coombs, Messrs. John Horsfall and Huntley Wilkinson.

The Chairman reported that as a result of reports received of the marked increase of Nettle Grub in the Passara district he had visited the estate, where the pest was most prevalent, with the Director and the Mycologist. As a result of this visit he considered it imperative that further arrangements should, if possible, be made to cope with the pest.

The Director mentioned that though the estate referred to by the Chairman had provided a bungalow for Mr. Austin, it was not big enough if the work were to continue for any length of time. Further accommodation would be required for the laboratory and insectory and also for the additional staff it was hoped to provide for this work. These additions would be capital expenditure and it was a question whether the Institute should bear the cost.

The Chairman proposed that the Institute should not undertake any capital expenditure with reference to this and similar investigations but would be quite willing to provide the necessary scientific staff. This was agreed to.

The Chairman stated that he had been informed that Dr. Snyder from the U.S.A., had been engaged to investigate Termites in India. He considered that an effort should be made to get Dr. Snyder to visit Ceylon officially as well.

It was decided to circulate the papers in this connexion to the members of the Board for their views thereon.

COMMISSION ON PADDY CULTIVATION

MINUTES OF THE FIRST MEETING HELD ON MARCH 18TH, 1931

1. A meeting of the Commission was held in Committee Room No. 3 in the Council Chamber, Colombo, on Wednesday, March 18th, at 10 a.m.

The following members were present: The Hon. Dr. W. Youngman, *Director of Agriculture (Chairman), Hon. Sir H. M. Fernando, Hon.* Messrs. D. H. Kotalawala, E. R. Tambimuttu, H. R. Freeman, G. E. Madawela, the Director of Irrigation, Messrs. A. L. J. Croos Da Brera, *H. L. de Mel, C. Drieberg, L. Lord, J. H. Meedeniya, T. B. Panabokke,* R. C. Proctor, J. C. Ratwatte, L. McD. Robison, Mudaliyar W. A. Samarasinghe, the Divisional Irrigation Engineer, W.D., the Registrar, *Co-operative Credit Societies,* with *Mr. J. C. Drieberg (Secretary)* in attendance.

The following members were unavoidably prevented from attending the meeting: Hon. Messrs. K. Balasingham and W. A. de Silva, Sir Stewart Schneider, Messrs. A. W. Winter and K. Kanagasabai.

2. In his opening remarks, the Chairman drew attention to the purpose of the Commission, namely to make recommendations to assist the paddy industry and to improve the conditions under which it was carried on, and said that it would be competent for the Commission to advise on any means to effect these ends. Certain terms of reference for this purpose were given them.

The Chairman suggested the formation of four Sub-Committees as indicated in the terms of reference, the membership of each being 7 with the Chairman as an ex-officio member of all the Sub-Committees. The Secretary would be at the disposal of any of the Chairmen at any time.

Each Sub-Committee would select its own Chairman, with a view to keeping the several Sub-Committees up to strength and in order that it may be possible for any members whose services would be helpful on more than one Sub-Committee to serve in another group, the Chairman suggested he be empowered to add two additional members to each sub-Committee as necessity arose.

At the conclusion of their duty the Sub-Committees would report to the General Commission which would decide in full meeting upon the points presented by each.

The desirability of arriving at conclusions in a reasonable time was stressed, and the Chairman further drew attention to the necessity of indicating some order of importance in which the findings of the Commission should be taken up.

3. After discussion it was agreed that:

(1) Communications and transport should be linked to irrigation and drainage;

(2) Village irrigation works should not be separated from major irrigation works, inasmuch as they all formed one system;

(3) That credit and marketing should go together with tenancy conditions;

(4) The number of, Sub-Committees should be reduced to three.

To a suggestion that item 6 of the terms of reference was a small one, the Chairman said that the importance of rural education would be seen at the end when the recommendations of the Sub-Committees were being considered in full Commission, as it was through this means that many of the ideas in the conclusions could possibly be given effect to.

Proposed by Mr. Ratwatte and seconded by Mr. Madawela that three Sub-Committees be formed, dealing respectively with items 1, 2 and 4; items 3 and 5; and item 6.—Unanimously carried.

The following proposals were unanimously agreed to by the meeting:

(1) That the Sub-Committees should, in the first instance, consist of 8 members;

(2) That the Chairman should be a member of all the Sub-Committees;

(3) That the Chairman be empowered to nominate two members to any Sub-Committee, if necessary;

(4) That the Chairmen of Sub-Committees would best be unofficial members.

4. With regard to the suggestion that travelling should be curtailed as much as possible, the Chairman said that the point would be borne in mind, but it should be left to the sense of the Sub-Committees.

Sir Marcus Fernando enquired whether the question of malaria in the paddy-growing districts would not be considered, and agreed to abide by the suggestion of the Chairman that it be dealt with at the end by the full Commission under general recommendations necessary to assist the paddy industry.

Any other general matters such as customs and measures which acted oppressively on cultivators, raised by Mr. Proctor, would be dealt with in like manner.

Mudaliyar Samarasinghe raised the question of the economic aspect of paddy cultivation, and was assured by the Chairman that it would be considered by the Sub-Committee on credit and marketing and not be lost sight of by the Commission as a whole.

5. The formation of the Sub-Committees was next dealt with by members stating on which Sub-Committee each desired to serve. Of the members present 8 expressed willingness to serve on Sub-Committee A, 7 on Sub-Committee B, and 3 on Sub-Committee C. Of the absent members, Sir Stewart Schneider was placed on Sub-Committee B, and Mr. W. A. de Silva on Sub-Committee C.

The Chairman stated that he would deal with the cases of Messrs. Balasingham, Winter and Kanagasabai.

To complete Sub-Committee C the meeting was requested to select 4 members from amongst those present, and Sir Marcus Fernando, Mr. Proctor, Mr. Meedeniya and Mr. Freeman, being proposed and seconded, were accordingly appointed. At this stage the composition of Sub-Committees was as follows:

Sub-Committee A—dealing with *Irrigation and Drainage, Communications and Transport*.—The Director of Irrigation, the Divisional Irrigation Engineer, Hon. Messrs. Madawela, Tambimuttu, Freeman, Mudaliyar Samarasinghe, Messrs. Panabokke, Proctor, the Chairman.

Sub-Committee B—dealing with *Tenancy, Credit and Marketing*: The Registrar, Co-operative Societies, Messrs. Lord, Croos Da Brera, Sir H. M. Fernando, Hon. Mr. Kotalawala, Messrs. Ratwatte, Meedeniya, Sir Stewart Schneider, the Chairman.

Sub-Committee C—dealing with *Rural Education.*—Messrs. Robison, Drieberg, de Mel, Hon. Mr. W. A. de Silva, Sir H. M. Fernando, Messrs. Proctor, Meedeniya, Hon. Mr. Freeman, the Chairman.

6. It was agreed that:

(1) The election of Chairmen be left to the respective Sub-Committees;

(2) A meeting of each Sub-Committee be held before the elections to the New State Council took place.

7. The Chairman said that it would not be necessary to fix a date on which the Sub-Committees should present their reports but that if delay occurred the attention of the Commission would be drawn to it.

It was not considered necessary to decide upon a quorum for Sub-Committees, but this point was to be borne in mind by them.

To a question by Mr. Tambimuttu, the Chairman stated that meetings of the full Commission would be held whenever necessary while the Sub-Committees were proceeding with their work.

In regard to literature, the Chairman requested members to communicate with the Secretary, whose special duty it would be to obtain all necessary documents. In this connection Sir Marcus Fernando drew attention to the scheme of vernacular agricultural education issued by a Committee in 1911 or 1912.

The following dates were fixed for meetings of the Sub-Committees:

Sub-Committee A on Friday 10th April at 11 a.m.;

Sub-Committee C ,, ,, ,, ,, ,, 2-30 p.m.;

Sub-Committee B ,, ,, 17th April at 11 a.m.

J. C. DRIEBERG,
Secretary,
Commission on Paddy Cultivation.

Peradeniya,
25th March, 1931.

DEPARTMENTAL NOTES

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA

FOR THE MONTHS OF JANUARY AND FEBRUARY, 1931

TEA

IN the report for September and October, 1930, a summary of the future plans of the station was given. It was stated that at the conclusion of the trial of *Indigofera endecaphylla* at the end of September, 1931, it was proposed to divide the tea area into two fields. As all the plots used in the above trial are included in the future field No. 1, and as no experiment is in progress in the plots which comprise field No. 2, the plucking of the latter plots as one field was started from January 1st, 1931. Owing to shortage of funds there is no immediate prospect of progress in the work of holing and planting up the strips which now divide the existing plots.

A further thinning out of *Albizzias* was carried out in plot 150. One more thinning will be necessary in a year or two.

During the drought in February the poor appearance of tea in the half-acre tea plot under *Albizzia chinensis* (*stipulata*), which was affording a negligible shade at the time, compared with adjacent tea under a much denser shade of *Gliricidia* was the subject of comment. This is a subject fully discussed in Section II of Manual of Green Manuring which is awaiting publication.

RUBBER

The tapping experiments in the Hill-top and Hill-side rubber were brought to a conclusion on December 31st, 1930. A final report on these experiments will be included in the next report. For the time being tapping has been stopped in both blocks in order to release labour for the other essential work to compensate for the reduction in the labour force rendered necessary by the reduction in funds allocated to the station.

In plots 151 to 154, where the rubber is to be eradicated after September, 1931, to make way for citrus, a new tapping to death experiment has been decided upon to run from April 1st to September 30th, 1931. This experiment is designed to clear up doubt as to the cause of the rapid drying up of cuts which has occurred in the rejuvenation experiment now in progress. There are 364 trees available and 91 trees will be allotted to each of the following treatments :

1. Alternate day tapping on one cut on the half circumference (control). Bark consumption 3 inches for 6 months.
2. Daily tapping on two cuts to the wood. Cuts one above the other. Bark consumption 6 inches for 6 months.
3. Alternate day tapping on two cuts to the wood. Cuts one above the other. Bark consumption 3 inches for 6 months.
4. Daily tapping on two cuts—ordinary tapping, not to the wood. Cuts one above the other. Bark consumption 6 inches for 6 months.

Tapping tasks to be changed round monthly.

CACAO

A large number of cacao trees have died during the past year. It is thought that the advanced age of this cacao may be partly responsible, but the immediate cause can usually be traced to bark canker which was very bad last year. This old cacao is overcrowded, and the fact that owing to pressure of other work no pruning beyond the removal of dead wood was undertaken in 1930 has possibly resulted in increased disease incidence. A considerable amount of labour has been employed in the period under review in digging out and cutting up these dead trees as well as in cutting up dadaps blown down in the recent strong winds.

At the conclusion of the present cacao manurial experiment at the end of March, 1931 it is proposed to simplify the organisation of the cacao areas by dividing them into ten blocks in place of the numerous existing plots. This scheme is detailed below :

Number of old plots.		Names of new blocks.
1, 2, 3, 4, 5, 6, 7, 8, 9, 10, Tundu A	...	Cattle shed block
107, 108, 109, 110, 111, 94, 95	...	Centre block
112, 113, 114, 115, 116 ...	...	Muniandy block
117, 101, 100, 99, 98 ...	...	Hillside cacao block
140 B	...	Temple block
119	...	Office block
"B" cacao	...	"B" cacao
88, 89, 90 91, 92, 93 ...	...	Totadeniya block
Tundu B	...	Tundu B block
134	...	Saibo's block

The following scheme of pruning is proposed for 1931 and following years :

1. In the centre block the trees are to be heavily pollarded. The dadap shade will not be lopped this year in order to minimise loss from exposure of branches to the sun. . Each tree will be treated on its own merits. A certain amount of thinning of cacao trees will also be done in this block. The above treatment will not take place before April 1st, at the termination of the cacao manurial experiment.

2. In the Hillside cacao block a gradual rejuvenation of the trees by allowing selected suckers to grow up is to be undertaken. The procedure this year will be as follows :

   (a) If the tree has one old stem and two young stems (grown up suckers), the old stems will be cut down and another sucker left to grow up so as to have three new stems.

   (b) If there are two old stems and one young stem, one of the old stems will be cut down and a sucker allowed to grow in its place.

   (c) If there are three old stems, one will be cut down and a sucker allowed to grow in its place.

   (d) If there are more than three old stems all except two will be cut down and one sucker will be allowed to grow.

3. All the other blocks will receive the same style of pruning as has been carried out in recent years, but slightly more drastic because no pruning beyond the removal of dead wood was done last year and the trees are now undoubtedly too dense. These blocks will act as controls for treatments 1 and 2.

It is proposed to record the yields and proportion of good and black cacao from these three treatments graphically over a number of years.

FODDER GRASSES

Four swampy paddy plots in the Panchikawatte fields have been drained with a view to planting up with Guinea grass during the next rains. When these plots are planted, about half the area of the old Panchikawatte paddy fields will be under fodder grasses.

TUNG OIL

In the block devoted to *Aleurites montana* in the Terraced Valley additional holes have been dug between the existing holes which, having been originally planted with *Hydnocarpus whightiana*, are spaced 25 feet from each other in the terraces. In addition, some new terraces have been dug, and there are now sufficient holes to accommodate the plants which are coming on in pots. Germination of *Aleurites montana* seed has been found to take from 6 weeks to two months but thereafter the plants have made vigorous and healthy growth.

The block devoted to *Aleurites* is still capable of further extension as plants become available.

GENERAL

The Tamil School which was formerly held in part of the implement shed has been re-opened in the old rubber room, which has been cleared and converted to this purpose. A new teacher has been appointed and attendance is good.

THE IRIYAGAMA DIVISION

A new area (area 4) has been laid out on the plan. It will contain eleven clones with H2 as control as usual. The trees growing in the land to be used for this area have been uprooted and the holes re-dug. Budwood of the eleven clones for this area is available in the nurseries.

A small block of 136 trees which lies to the south of area 1, and which is cut off by a road and therefore could not be included in a fresh area, was budded in the field with P.B. 23 at the end of December; spare plants were budded in the nursery. It was not thought that the time was a good one for budding and the percentage of success obtained in the field was very low. Fair success was obtained in the nursery. As plenty of budwood was available failures in the field were re-rubbed at once. Any further failures will be replaced by budded stumps from the nursery about April.

In the November-December report figures are given of the number of stumps in each clone of area 3 of which the buds had shot exactly five months after original budding. It was stated in that report that two clones

had not yet completed the five months period and for easy comparison the figures for all the clones are here given :

Clone.		Percentage of buds shot five months after original budding.
Heneratgoda	2	64·6
,,	401	31·3
,,	439	83·0
,,	203	81·5
,,	47	68·4
,,	24	73·5
Udapola	24	58·0
Milleniya	162	50·0
Hillcroft	34	75·0

Weather conditions were very similar for each clone and the large differences found indicate the possibility of quick shooting being a clonal characteristic.

In the nursery budding for area 2 where in each clone half the buds were put on to their own stocks and half on to ordinary mixed stocks no significant difference was found in the number of successes obtained. The percentage on own stocks was 92·7 and on mixed stocks 88·6. Measurements of the young budded trees at a later stage may reveal a difference in growth.

During the drought in February all plants in areas 2 and 7 and all supplies in area 3 were lightly forked round and mulched with green material.

A few casualties have occurred in areas 2 and 7.

In area 6 (the earliest planted area of foreign clones) at present every hole contains a growing tree.

T. H. HOLLAND,
Manager,
Experiment Station,
Peradeniya.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MARCH, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	173	66	37	107	20	9
	Foot-and-mouth disease	216	167	203	2	10	1
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	2*	...	...	...	...	2
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	193	45	155	6	32	...
	Anthrax (Sheep & Goats)	9	2	...	9	...	...
	Rabies	2	..	...	...	...	2
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Cattle Quarantine Station	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	..	...	...	...	...
	Anthrax	79	25	...	79	...	...
Central	Rinderpest	...	..	...	..	...	...
	Foot-and-mouth disease	14	...	14	...	...	...
	Anthrax	...	...	...	...	...	..
	Rabies (Dogs)	6	...	...	..	...	6
Southern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1032	28	870	5	157	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	..	...	...	
Northern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Black Quarter						
	Rabies (Dogs)						
Eastern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
North-Western	Rinderpest	3955	1129	74	3361	54	466
	Foot-and-mouth disease	...	...	...	...	..	...
	Anthrax	...	...	...	..	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	1899	471	241	1569	81	8
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	...	1	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	..	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	..	...	...	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1
	Piroplasmosis	1	...	1	...	...	...
	Haemerrhagic Septicaemia	5	...	...	5	...	...

* 1 case in a cow.

G. V. S. Office,
Colombo, 10th April, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

MARCH, 1931

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo	89.4	+ 1.4	75.0	+ 1.6	69	93	4.2	1.86	9	- 2.86
Puttalam	91.1	+ 2.3	73.2	+ 0.8	67	93	2.2	3.56	4	+ 0.59
Mannar	91.7	+ 1.7	74.5	- 0.2	63	90	1.4	0	0	- 1.48
Jaffna	89.4	+ 1.7	74.9	- 1.2	68	90	3.6	0.45	1	- 0.72
Trincomalee	—	—	—	—	—	—	—	—	—	—
Batticaloa	85.7	+ 0.3	75.2	+ 1.1	76	93	5.1	3.55	6	+ 0.41
Hambantota	88.4	+ 2.1	74.7	+ 1.7	68	88	3.7	0.23	3	- 2.35
Galle	88.6	+ 2.6	75.5	+ 0.3	72	88	4.6	2.05	9	- 2.69
Ratnapura	93.8	+ 3.7	73.0	- 0.2	67	93	2.9	5.95	18	- 3.05
A'pura	93.7	+ 2.8	72.9	+ 1.3	56	83	5.9	1.39	3	- 1.57
Kurunegala	95.9	+ 3.0	73.0	+ 1.1	54	90	4.9	1.71	4	- 3.53
Kandy	90.0	+ 3.2	69.5	+ 1.3	66	87	3.4	4.82	8	+ 0.63
Badulla	83.0	+ 0.6	65.1	+ 1.6	72	97	4.0	2.17	7	- 2.50
Diyatalawa	79.2	+ 2.9	58.2	+ 0.4	60	85	4.4	3.88	5	- 0.49
Hakgala	75.2	+ 1.8	53.2	+ 1.7	66	82	3.8	6.01	4	+ 0.45
N'Eliya	72.3	+ 1.3	45.5	- 0.1	63	93	3.8	3.10	4	- 0.41

At the great majority of stations the rainfall of March was deficient, a fact which was emphasised by cumulative effect after a dry February. Such rain as did occur fell chiefly between the 5th and 14th, and was largely of the local thunderstorm type, while hail was reported on the 9th south-west of Ratnapura, *e.g.*, in the Kukul Korale.

The areas in which the total for the month were above 5 inches comprised Sabaragamuwa and extended southward to include the extreme south of the W.P., and most of the western half of the S.P. It also extended eastward to include most of Dimbula and Dickoya and thence along the southern limit of the hills to Koslanda and Poonagalla. The highest totals were at Geekiyanakanda and West Haputale, each of which reported 12.73 inches. Comparatively few stations passed their average, those that did so being chiefly in the south-west quarter of the C.P. and in the S.P., though there were a few in the N.W.P.

The smallness of the averages prevented any great deficits in the north and east, but several stations in the N.P., N.C.P., and northern part of the E.P. recorded no rain at all, and hence were in deficit by the amount of their averages.

As will be seen in the table above, temperatures were pretty consistently above average.

The duration of bright sunshine was appreciably above average, while humidity and amount of cloud were both in deficit.

A. J. BAMFORD,

Superintendent, Observatory.

The

Tropical Agriculturist

May 1931

EDITORIAL

REPORT OF THE COMMITTEE ON SOIL EROSION

THE Report of the Soil Erosion Committee has been in the hands of the public for some three months. Everyone interested in the agriculture of the Island has now had time to make himself acquainted with the situation as presented by the Committee. The problem now is very largely a personal one. What is each individual concerned in any way with the terrible state of affairs shown in the Report going himself to do? To prevent a continuation of such things as have been going on in the past is the plain duty of all concerned. The Committee has taken what seems to many to be very optimistic ideas of the powers of education. It thinks, that educative methods should be tried for a period of five or seven years before compulsion by legislation should be considered. *"Without deprecating the enormous significance of internal damage to the Island as a whole the Committee has decided that, until the possibilities of propaganda, persuasion, and example have been exhausted, it is not desirable to recommend Government interference with private property. The Committee considers, however, that after educative methods have been tried for a limited period, say five years, or if the present depression continues, seven years, the subject should be brought up for review on the understanding that, if conditions are still unsatisfactory, compulsion by means of legislation should be further considered."* Unfortunately educative methods do not by themselves always prove sufficient to enforce amongst men the control of plant pests and animal and human diseases of a virulent, and even infectious, type, and it is difficult to see why they should be expected to do so in this problem of soil erosion. The difficulty is all the more

so in that the dread of being oneself the subject of infection in the case of disease has itself an educative influence of a salutary nature. Fear as an educational method is a very powerful one in the human mind although perhaps not recommended by present-day psychologists. In the case of soil erosion no such educational influence is by itself to be looked for but rather the reverse, for soil erosion is often the result of the encouragement of hoped-for sordid gain. Everything that is best in human nature is therefore needed to encourage us to consider this problem from the standpoint of the Island's good. If the good sense of the planting community can be brought to cry, in large measure, a halt to soil erosion, it will greatly redound to its credit. It is to be hoped that all Planting Associations will give the fullest consideration to this Report by discussion at their meetings and precept on their estates. Every planter should consider it his duty to make himself thoroughly acquainted with it. The greatest assistance could come from Planters' Associations if they would constitute themselves as vigilance committees and call the attention of any erring members to soil erosion on their lands. The Report is circulated to all field officers of the Agricultural Department and their attention called to the necessity to do what they can to educate and direct the small-holder along lines of soil conservation. It is to be hoped that these and many other educative means may bear fruit, but they can only do so if the immensity and importance of the problem be realised and grappled with by all concerned. Let us see to it that this is the case.

A MANURIAL EXPERIMENT WITH CACAO

T. H. HOLLAND, DIP. AGRIC. (WYE),
MANAGER, EXPERIMENT STATION, PERADENIYA

A CACAO manurial experiment at Peradeniya was brought to a conclusion on March 31st, 1931.

The plan of the experiment was as follows:

Sixteen plots of approximately one acre each were used, and these were divided into four groups of four plots each, each group containing one plot of each treatment. Each plot was given a letter denoting the treatment, followed by the permanent number of the plot. The four treatments were:

A plots 250 lb. Superphosphate per plot per annum.
B ,, 100 lb. Muriate of Potash per plot per annum.
C ,, 250 lb. Superphosphate and 100 lb. Muriate of Potash per plot per annum.
D ,, (Control). No manures, but the same cultural treatment as the manured plots.

All manures were applied in the month of January each year and were lightly forked in with mamoty forks. The D plots received a similar light forking at the same time.

In each group the control plot (D plot) was not selected by randomisation but the plot which had given the highest average yield over the four years prior to the first application of the manures was taken.

Records were maintained of the wet weights of good and black cacao in each plot and these figures were converted into good dry and black dry weights at 38 per cent and 21 per cent respectively; these figures being the actual average out-turn in each grade over a period of six years. Conclusions were to be based on the average annual yields of the A, B, and C plots relative to the D plots without manures during the four cacao years 1923-24, 1924-25, 1925-26, and 1926-27, compared with the average annual yields of the A, B, and C plots relative to the D plots with manuring in the four cacao years 1927-28, 1928-29, 1929-30, and 1930-31. In other words, since the D plots were in each group the highest yielders in the first period it was intended to see whether the lead of the D plots over the A, B, and C plots was reduced by manuring the latter. In addition to yields, the intention was to study the effect of manuring on pod canker incidence by comparing the proportion which good cacao formed of the total crop in the two periods.

The total yields of good and black cacao will first be considered in tables I, II, and III. To avoid presenting a bewildering mass of figures, only the average yield of the four years in each period are shown. The yields of the four plots (one in each group) which have received the same treatment are shown together.

Table I

Yields of plots manured with 250 lb. of Superphosphate per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Average annual yield of dry cacao in manured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
A5 (Group 1)	370	-13·6	351	-28 0	-14·4
A9 („ 2)	364	-23·2	410	- 9· 3	+13·9
A115 („ 3)	457	- 6·1	476	- 4· 6	+ 1·5
A9/ („ 4)	369	-30·6	511	-34· 2	- 3·6
Average	390	-18·4	437	-19· 0	- ·6

From these figures it would appear that although in two plots, A 9 and A 115, a reduction has been effected in the decrease over the control plot, in the other two plots, A 5 and A 91, the decrease has been further accentuated and the indication is that the application of superphosphate has on the average failed to improve the position of these plots relative to the control plots.

Table II

Yields of plots manured with 100 lb. Muriate of Potash per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Average annual yield of dry cacao in manured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
B 4 (Group 1)	387	-13 6	304	-37·5	-23·9
B 95 („ 2)	405	-14·4	562	+24·4	+38·8
B114 („ 3)	463	- 4·9	429	-14·0	- 9·1
B 90 („ 4)	389	-26·9	470	-39·4	-12·5
Average	411	-14 9	441	-16·6	- 1·7

In this case also, though a substantial improvement has occurred in B 95, on the average the manured plots are left even further behind the control plots.

Table III

Yields of plots manured with 250 lb. of Superphosphate and 100 lb. of Muriate of Potash per acre per annum.

Plot	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in the same group	Average annual yield of dry cacao in unmanured period lb.	Percentage increase or decrease over control plot in same group	Difference of percentage increase or decrease over control plot in manured period compared with unmanured period
C109 (Group 1)	425	- ·7	472	-3·1	-2·4
C8 (" 2)	422	-10·9	403	-1·9	+9·0
C116 (" 3)	474	- 2·6	485	-2·8	- ·2
C 92 (" 4)	472	-11·3	710	-8·6	+2·7
Average	448	- 6·4	517	-4·1	+2·3

Once again we find that in two plots the yields have fallen still farther behind those of the controls, while in the other two plots an improvement has taken place. On the average the relative yields of the plots have improved by 2·3 per cent.

The experiment affords no valid evidence that yields have been increased by the application of either superphosphate, muriate of potash, or a mixture of the two.

It is true that this percentage-increase method is not considered a reliable one, but it is reasonable to suppose that, if the application of the manures had exerted any influence, a greater change in the relationship of the yields of the manured plots and those of the control plots would have appeared. In this connection it is of interest to note Lock's [1] summing up of the results of cacao manuring experiments carried out on the station between 1902 and 1911. He says: "We find, therefore, that the differences of crop which can be attributed to the action of definite chemical constituents are extremely slight, and it seems clear that the continued application of most artificial manures to a cacao soil like that of Peradeniya is a waste of money, under the conditions of this experiment."

The present writer made some remarks on this point in the Progress Report for the Station for the months of May and June, 1930. The following is the extract referred to:

"The yields of dry cacao per acre for the last seven years have been as follows:

Year		Cwt. per acre of dry cacao	Rainfall
1923-24	...	2·24	106·42
1924-25	...	3·10	103·82
1925-26	...	5·45	87·31
1926-27	...	5·03	98·11
1927-28	...	4·41	80·33
1928-29	...	2·49	88·95
1929-30	...	4·58	98·71

"From 1921 to January 1928, no manures were applied to the cacao. From January 1928, twelve out of the forty-one acres of cacao have received phosphatic and potash manures in accordance with the manurial experiment now in progress. The above yields tend to show that cacao yields fluctuate far more with the season than as the result of any manurial treatment."

To sum up it appears more than likely that there is no deficiency of phosphoric acid or potash in these soils and that in consequence the application of the manures has exerted no obvious effect.

One notable point is that all the three manured plots in group 2 show an improvement in yield relative to the control plot while no plot shows an improvement in group 1, and only one plot each in groups 3 and 4. This is difficult to explain. The plots which comprise group 2 are some of the best on the station and there is no obvious reason why they should have benefited more by the application of the manures than the plots in the other groups.

It is now necessary to examine the question of disease incidence. The average percentages of good cacao of total crops in the two periods are found in table IV for all three treatments.

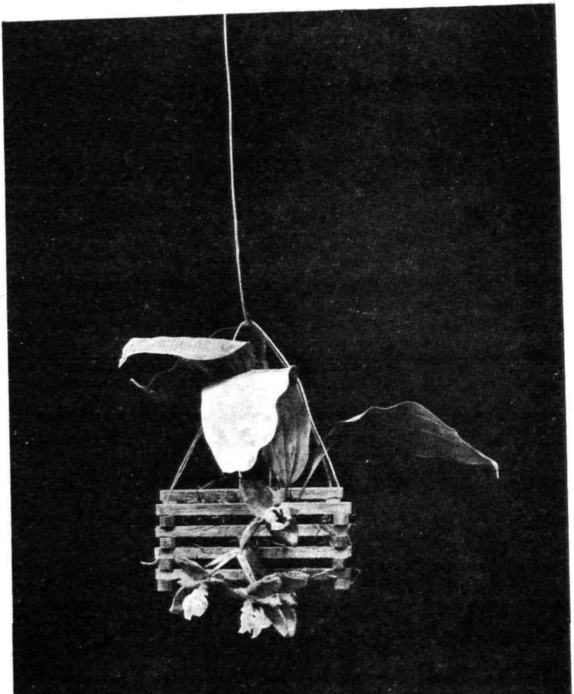
Table IV

Plot	Average percentage good cacao of total crop in manured period	Same figure for control plot in same group	Increase or decrease in percentage good cacao over control plot	Average percentage good cacao of total crop in manured period	Same figure for control plot in same group	Increase or decrease in percentage good cacao over control plot	Difference of percentage relative to with control plot for manured period compared with unmanured period
A 5	76·2	76·4	− ·2	73·0	81·0	− 8·0	− 7·8
A 9	76·1	75·5	+ ·6	78·0	76·6	+ 1·4	+ ·8
A 115	79·2	78·9	+ ·3	79·0	83·2	− 4·2	− 4·5
A 91	77·5	79·5	− ·2	82·1	85·0	− 2·9	− 2·7
Average	77·2	77·6	− ·4	78·0	81·4	− 3·6	− 3·2
B 4	77·2	76·4	+ ·8	76·4	81·0	− 4·6	− 5·4
B 95	74·3	75·5	− 1·2	83·1	76·6	+ 6·5	+ 7·7
B 114	78·4	78·9	− ·5	83·0	83·2	− ·2	+ ·3
B 90	71·5	79·5	− 8·0	82·3	85·0	− 2·7	+ 5·3
Average	75·3	77·6	− 2·3	81·2	81·5	− ·3	+ 2·1
C 109	77·3	76·4	+ ·9	80·2	81·0	− ·8	− 1·7
C 8	73·7	75·5	− 1·8	79·3	76·6	+ 3·3	+ 5·1
C 116	81·4	78·9	+ 2·5	78·1	83·2	− 5·1	− 7·6
C 92	77·9	79·5	− 1·4	83·6	85·0	− 1·4	nil
Average	77·6	77·6	nil	80·3	81·4	− 1·1	− 1·1

If the application of manures has failed to increase the total yield it would appear unlikely that it would result in an increase in the proportion of good cacao, and from the figures in table IV this does not in fact seem to have occurred. The relative position of the superphosphate plots compared with the control plots as regards proportion of good cacao is worse by 3·2 per cent than before manuring. The muriate of potash plots show a small improvement of 2·1 per cent but the plots which have received both these manures show a deterioration of 1·1 per cent. There is little doubt that no influence has been exerted on the incidence of pod canker.

LITERATURE CITED

(1). Lock, R. H.—Report on Experiments in Manuring Old Cacao, carried out at the Experiment Station, Peradeniya, between 1903 and 1911.—*Circ. and Agric. Journ. R. B. G., Ceylon.* Vol. *VI*, No. 4.



Stanhopea ecornuta Lem

STANHOPEA ECORNUTA

K. J. ALEX. SYLVA, F.R.H.S.,
ASSISTANT CURATOR,
HENERATGODA BOTANIC GARDENS

Stanhopea ecornuta Lem. belongs to a most beautiful though not very extensive genus of epiphytic Orchids of the Vanda tribe. With the exception of *Stanhopea grandiflora*, which is a native of Trinidad, the majority of these are endemic in South and Central America.

The plants are pseudobulbous with broad shining deep-green membraneous plicate leaves. The flowers are peculiarly formed and of a very complex shape; the labellum and column forming together an exquisite cage-like structure, which narrows downwards and is of a waxy consistency. The flowers are large and beautifully spotted, and exhale a strong aromatic fragrance like that of Vanilla. The sepals, which all point upwards, are ear-like, about two inches long, concave, fleashy, and of a pleasing creamy-white colour.

The plant, owing to its pendulous flower racemes, is best grown in a shallow wooden basket, otherwise, the free development of the raceme is liable to be checked and result in deformed blooms. The rooting compost, as far as possible, should be of a fine character; and should consist of equal parts of broken charcoal, bones, coconut fibre, and sphagnum moss. When in active growth the plant should be given an ample supply of water and placed in a warm position though sheltered from direct sunlight. After the flowers are open the plant may be removed to a cooler position and watering reduced to once or twice a week. The flowers being very sensitive and delicate, care should be taken to avoid wetting them.

CONTRIBUTIONS FROM THE RUBBER RESEARCH SCHEME, CEYLON

DISEASES OF RUBBER IN CEYLON, 1930

R. K. S. MURRAY, A.R.C.Sc.,
MYCOLOGIST,
RUBBER RESEARCH SCHEME (CEYLON)

1. INTRODUCTION

THIS article is the second of a series of annual reviews on the general position of Rubber diseases and pests in Ceylon. The object of these articles, as stated on a previous occasion (1), is to keep planters in touch with the general disease position, and to acquaint them briefly of any important developments during the year under review.

2. ROOT AND COLLAR DISEASES

As regards fungus diseases there are no new developments to report for 1930. The low price of rubber has unfortunately necessitated the curtailment of control measures against the two most important fungi, *Fomes lignosus* and *Ustulina zonata*, and it is feared that considerable loss on account of these diseases may consequently be experienced in certain districts during the next few years. Every possible care to prevent the spread of root disease and *Ustulina* collar and stem rot should be taken, so that the necessity for the expenditure of large sums of money in the future may be avoided.

Termites.—A number of instances of attack on Rubber trees by termites ("white-ants") have been reported in Ceylon during the year. In Malaya and the Dutch East Indies *Coptotermes gestroi* has for some years been notorious as a root parasite of *Hevea*. This species, however, is not known in Ceylon, and until recently it was believed that none of the Ceylon termites were able to attack healthy Rubber trees. Unfortunately this view can no longer be entertained, and in the light of recent observations it is possible that the concern with which these pests have been regarded by the Tea planter for many years may, in future, be shared by the Rubber planter also.

An account of termite attack on *Hevea* in Ceylon is given by Jepson (2) in Rubber Research Scheme Quarterly Circular Vol. 7, Part 3. Broadly speaking there are two types of termite attack on *Hevea*:

(1) The termite can only gain entrance through dead or diseased wood such as is provided by *Ustulina* attack or a broken branch. Having thus gained entrance, however, it can attack and destroy healthy wood and may penetrate to the roots, thus causing the ultimate death of the tree. Certain species of *Calotermes* have been found attacking *Hevea* stems in this way. Such attacks can be guarded against by the removal of dead and diseased branches.

(2) The termite can gain entrance underground through a healthy root, and, working upwards, may hollow out the trunk and kill the tree. One species, *Coptotermes ceylonicus*, has been found attacking *Hevea* in this way, though it has usually been associated with a root disease fungus. This is the most dangerous form of attack and no effective preventive measures can be taken.

In view of the lack of precise knowledge regarding the habits of some of the genera and the circumstances under which they may attack *Hevea*, further records and specimens will be welcomed.

3. STEM DISEASES

On those estates which stopped tapping during May, the incidence of Bark Rot when the cuts were re-opened in June was not so severe as had been anticipated. Although this was largely due to the comparative failure of the S. W. monsoon there is no doubt that this disease can be almost entirely prevented if careful control measures are adopted.

Canker is not considered to be of much importance except where the actual tapping surfaces are effected. At the present time, when the expenditure on disease treatment must, in common with all other items, be reduced to a minimum, it would be advisable on most estates to transfer the money usually spent on canker scraping to the control of root disease and *Ustulina*.

4. LEAF DISEASES

Secondary leaf-fall due to *Phytophthora palmivora* (*P. Faberi*) was not serious in 1930. It is possible, however, that the effects of this disease may become more marked while the low price of rubber necessitates the curtailment of regular manuring and cultivation.

Oidium.—In the main low-country districts the intensity of *Oidium* attack has not increased to any serious extent since the disease was first reported in 1925. Although the disease is now widespread it would appear that the conditions in the low-country are not favourable to prolonged spells of severe infection. At mid-country elevations, on the other hand, the fungus continues to cause extensive and serious defoliation on many estates, and

there is evidence of considerable decreases in yield due to the disease. A fair measure of control has been secured by means of sulphur dusting, and it is confidently expected that further experiments will achieve better results.

It is of interest to note that Beeley [3], in Malaya, has found that the fungus sporulates more actively in a cold chamber (55°F) than at a normal tropical temperature. There can be no doubt that this fact provides the main explanation for the greater intensity of the disease at higher elevations in Ceylon.

A leaf scorch due to the application of calcium cyanamide in dry weather was much in evidence during the year. The margin of the leaf blade dies back and becomes whitish in colour, and the appearance is similar to that of a rim-blight of fungus origin. In severe cases the leaflets may fall. It is generally supposed that the burning is due to the formation of dicyanodiamide, a toxic compound which is liable to be formed in the absence of sufficient moisture. This manure is of great benefit when applied under suitable conditions, but it should not be applied in dry weather, particularly to soils deficient in humus.

5. DISEASES AND PESTS IN NURSERIES

The establishment of budwood nurseries for the multiplication of high-yielding clones has been undertaken by most companies, and nearly every estate in the main rubber-growing districts now possesses a certain number of stumps budded from proved foreign clones. The possession of such valuable planting material has focussed attention on the various ailments to which young shoots are prone.

The most serious fungus disease of young rubber buddings is a die-back of the green shoot caused by *Phytophthora palmivora*, the symptoms of which have been described by Murray [4]. Its incidence is markedly dependent on wet weather, and under favourable conditions a young shoot may be killed back in a few days. It is necessary, therefore, to keep a careful watch on nursery plants and to cut back any diseased shoots well below the margin of the discolouration. Successful control has been secured on many estates by periodically spraying with Bordeaux Mixture.

An attack on young bud shoots by *Rhizoctonia solani* was reported by Park [5] from an estate in the Kalutara district. This fungus is a common cause of disease on *Vigna* (*Dolichos Hosei*), but has not previously been reported on *Hevea*.

Various pests attack young shoots and check their growth. Mites cause distortion of young leaves chiefly in dry weather, and are most effectively controlled by dusting with sulphur powder. Slugs are often found to eat off the terminal shoot. By day it is

usually possible to find the slugs under stones, etc., and flat boards may be put down to trap them. They may be to some extent discouraged by periodically dusting with smokehouse ashes, and by putting a barrier ring of ashes on the ground round each plant.

It is a sound practice to spray all young shoots of valuable bud-grafted material with Bordeaux Mixture every week or ten days during wet weather, and to dust them periodically with sulphur powder during dry weather.

[For further particulars regarding diseases and pests in nurseries reference may be made to *Rubber Research Scheme Quarterly Circular* Vol. 7, Part 3, 1930, (6)].

COVER CROPS

The impression has been gained that the Kalutara snail (*Achatina fulica*) is not now causing so much damage to *Vigna* as formerly. The dying back of many areas of this cover is probably to be attributed to staling effects.

There has been no extensive fungus damage to cover crops.

REFERENCES

(1). Murray R. K. S.—Diseases of Rubber in Ceylon, 1929. *Rubber Research Scheme Fourth Quarterly Circular* for 1929, p. 5.

(2). Jepson F. P.—Termites attacking *Hevea brasiliensis* in Ceylon, *Rubber Research Scheme Quarterly Circular*, Vol. 7, Part 3, p. 35, 1930.

(3). Beeley, F.—Mildew Disease of *Hevea*. *The Malayan Agricultural Journal*, Vol. XVIII, 12, p. 596, 1930.

(4). Murray, R. K. S.—A Disease of Young Bud-Shoots caused by ***Phytophthora palmivora***, Butler, *Rubber Research Scheme Quarterly Circular*, Vol. 7 Part1, p. 10, 1930.

(5). Park, M.—Mycological Notes (22). Matters of Phytopathological Interest during 1929. *The Tropical Agriculturist*, Vol. LXXIV, 4, p. 195, 1930.

(6) Murray, R. K. S.—Some Common Pests and Diseases of Young *Hevea* Buddings. *Rubber Research Scheme Quarterly Circular* Vol. 7, Part 3. p. 51, 1930.

THE EFFECT OF BLANKETING ON THE PLASTICITY OF CREPE

G. MARTIN, B. SC., A.I.C., F.I.R.I.
AND
L. E. ELLIOTT, F.I.C., F.I.R.I.
(OF THE SCIENTIFIC STAFF IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME)

IN Bulletin 49, p. 7, attention was drawn to a statement by Mr. O'Brien that "the procedure adopted in blanketing crepe varies considerably. For example in certain factories water-cooled rolls are used so that the temperature of the rubber is kept low. On other estates uncooled rolls are used, but are allowed to cool down after half-an-hour's work. Again on other estates there is no interval for cooling and the rubber temperature may rise to 50-55°C. The number of rollings may vary from three to five."

A set of samples was therefore prepared to determine the effect of different practices during blanketing on tbe plasticity of crepe, and it was concluded from the results of tests that rolling for blanketing purposes might cause a considerable increase in plasticity particularly if the rolls were not water-cooled. Some of the results were irregular and required confirmation.

A further set of samples has now been prepared to study the effect on plasticity of conditions of rolling during blanketing. The samples consist of lace crepe (control), crepe passed three and six times respectively through water-cooled blanketing rolls, and crepe passed three and six times respectively through somewhat hotter air-cooled blanketing rolls.

The following are the results of plasticity tests:

Sample No.	Treatment during blanketing	Before storage	After storage for six months at 32°F		60°F	
		D_{30} mms / 100	D_{30} mms./ 100	Mastic-ation No.	D_{30} mms./ 100	Mastic-ation No.
1496	Lace crepe (control)	171	155	92	165	93
1494	3 rollings water-cooled rolls. Temperature of rubber 41°C	155	170	100	168	99
1497	6 rollings water-cooled rolls	160	153	97	162	97
1498	3 rollings air-cooled rolls	156	155	95	162	100
1499	6 rollings air-cooled rolls. Temperature of rubber 58°C	156	145	87	151	84

The samples were tested soon after arrival in London and the control lace crepe was found to be distinctly harder than the blanket crepe samples. On storing for six months at 60°F, however, the control sample became softer and did not differ greatly from the others.

The sample which was blanketed under extreme conditions by rolling six times on comparatively hot rolls became much softer than the others on storage and required less mastication. The other samples did not show marked differences.

It is concluded that blanketing has little effect on plasticity when the temperature of the rolls is kept low but that it may have a marked effect if the rolls become hot. On the whole this agrees with the results of previous tests (Bulletin 49, p. 7). To obtain rubber of uniform plasticity it is desirable that the blanketing rolls should be water cooled.

NEW DATA ON THE LATEX TUBE BORE IN RUBBER*

AT the end of 1928 Mr. H. Ashplant, the rubber specialist, United Planters' Association of Southern India, gave a lecture on latex tube bore before the Rubber Growers' Association in London; it was published in the Bulletin of the "Rubber Growers' Association," Vol. X., No. 12, December 1928, p. 796. The original ideas and the new data, put by him before his audience, stirred up somewhat the rubber world. Most research workers in the rubber-growing industry were sceptic about the new method, a selection based on the latex tube bore, as a means for improving the planting material with rubber. In more than one station investigations about the new subject were started, but heard little about the results. Recently one of the members of the staff of the AVROS Experiment Station in Sumatra, Dr. Frey-Wyssling, has published the results of a careful study of the tube bore character (in the *Arch. v.d. Rubbercultuur in Ned. Indie,* Vol. XIV., No. 3, March 1930, p. 133, "Investigation into the relation between the diameter of the latex tubes and rubber production of Hevea brasiliensis"). Dr. Frey-Wyssling's data do not confirm Mr. Ashplant's theory.

Before going into the subject we must mention here a serious handicap for Mr. Ashplant. Circumstances did not allow him to give us further details about his method and more data on the application of it. There was certainly an excellent starting idea in his work. If we could find a reliable character to make out, if a young seedling in the nursery belongs to the group of future high-yielders always found among seedlings, this would mean an immense progress for the rubber-growing industry. Mr. Ashplant had the original idea to try to find it in the latex tube bore and he found a clever solution for many difficulties in relation to it by choosing the leafstalk for studying this character. Whatever the future development of Mr. Ashplant's method may be, he has certainly the merit of having given a new stimulus to investigations into the anatomy of Hevea bark.

The Difficulties of the Technique.—Up till now Mr. Ashplant has not described the technique of his method and Dr. Frey-Wyssling had, therefore, to spend much time in working out a flawless micro-technique for measuring the diameter of the latex tubes. He has given a very complete description of his methods; the results showed how difficult and delicate a work the measuring of the latex tubes is. To make the microscopical preparations two methods were tried; (1) the maceration method, and (2) the Eau de Javelle method. For calculating each average figure 100 measurings were made. The following figures were found:

(1) The figures are taken from Dr. Frey-Wyssling's article but some details are left to make the form as clear and plain as possible.

* By Dr. P. J. S. Cramer, Wassenaar, Holland, in *The Malayan Tin and Rubber Journal,* Vol. XX, No. 22, 1931.

Table I

Average Diameter of Latex Tubes

Individual number	In the bark Bark samples prepared by mac. method	In microne 1 Bark samples prepared by E.D.J. method
(a) Artificial crosses seedlings.		
Tree No. 1 ...	26·7 ...	23·8
,, No. 4 ...	28·2 ...	27·0
,, No. 6 ...	27·9 ...	24·7
(b) Marcots of cl. 180.		
Tree No. 8 ...	25·6 ...	22·9
,, No. 10 ...	57·6 ...	23·3
,, No. 12 ...	26·6 ...	22·7

The figures show that samples of the same tree, prepared by the maceration method, gives us always a higher figure, sometimes a considerably higher figure (Tree No. 10, 4·3 microns) than the Eau de Jevelle method. The three last trees are all marcots of the same clone and should, according to Mr. Ashplant's theory, all have the same average for the tube bore; even prepared with the same method, the samples show a difference for the average of 2 microns. This makes this method unreliable.

Dr. Frey-Wyssling used for calculating his averages 100 measurements of the same tree; by a mathematical reasoning he shows that this figure is sufficient, but that, if only 10 measurements were made per tree, quite valueless averages would be obtained.

Mr. Ashplant assures that this method cah be applied with 80 per cent. efficiency. Without a detailed description it is not clear how he avoids the difficulties mentioned by Dr. Frey-Wyssling. With the experience of the last, one would say that, when the method has to he applied in estate practice and the measurements made by native staff it will require a good deal of supervision to get, with such a delicate and complicated method, reliable results.

I would not dwell further upon this point. Let us take it for granted, that the men, who do the work, do it as well as the botanists in the laboratory and examine them, if the method gives the results Mr. Ashplant expects from it.

The Figures with Buddings.—The difficulty is, that we need years to compare the character—the average width of the latex hore in young plant with the yield of the adult tree. Dr. Frey-Wyssling tried to overcome this difficulty by using six months old buddings, instead of six months old seedlings. We have the advantage with buddings, that we know beforehand, what they will give as adult trees.

Dr. Frey-Wyssling used for this test twelve popular AVROS-Clones all planted on a large scale now in Sumatra and for the largest part also used in experimental plots, for which the yield has been studied for a number of years. He gives his results in a table, which we have rearranged to make it speak more clearly. For each clone the average width of the latex tube was measured and calculated.

We have now classified the clones according to the width of their tubes.

Table II

Yield and Tube Width with Clones.

Clone Number	Aver. diameter of latex tubes in leaf-stalk	Grams of dry rubber per tapping in tapping year In 1st Year	In 2nd Year	In 3rd Year
50	16·4 microns	6·1	14·7	30·3 grams
49	16·5 ,,	6·2	14·5	21·3 ,,
35	17·3 ,,	6·8	16·3	18·3 ,,
33	17·4 ,,	5·5	11·2	23·8 ,,
80	17·5 ,,	6·3	12·1	15·2 ,,
163	17·5 ,,	7·8	12·7	20·8 ,,
152	17·6 ,,	9·7	17·1	2[illegible]·6 ,,
36	17·8 ,,	4·2	10·0	20·3 ,,
214	18·3 ,,	15·2	—	—
71	18·6 ,,	7·8	12·8	21·8 ,,
183	18·8 ,,	14·8	24·0	—
256	19·3 ,,	—	—	41·7 ,, (4th tap year.)

If we compare these figures with those for common seedlings, we find that none of these clones shows an outstanding figure for its tube diameter, compared to common seedlings. If we read through the figures for the yields in the second and third year we do not find back the same consequence as in the classification of the tube diameter. Clone 50, one of the best yielders in third year, heads the list, that means shows the lowest tube diameter. Clone 71, one of the lower-yielding clones, comes near to the top with its bore.

But more than these relatively small differences says the following case. The AVROS Station disposes of one clone, used for comparisons, of a very poor yield—in its first year it gave only 0·6 gr., in its second year only 1·3 gr., and the latex tube diameter of this very poor clone averages 18·1 microns, which places it among the ones with a diameter above the average.

Results of Selection on Tube Width.—Another way to put the selection method recommended by Mr. Ashplant through the proof is by applying it. We can use for such a practical proof the 239 trees Mr. Ashplant studied himself and further two sets of trees described by Dr. Frey-Wyssling. In these three cases the yield of the adult tree is given together with the average tube width in the leafstalk. As, according to Mr. Ashplant, this character remains constant throughout the life of the tree, we can figure ourselves that we selected the trees, when still young, on the tube diameter, planting out only those with the highest average.

(a) *Mr. Ashplant's Trees.*—Table III is copied from Mr. Ashplant's lecture; it is only somewhat simplified and a few printer's errors have been corrected. In the horizontal direction the trees are classified according to yield, in the vertical direction according to tube width. The average yield of all the trees is 32·5 cM^3. Mr. Ashplant has calculated, that early selection by means of bore measurements can give a stand of rubber 2½ times the yielding capacity of present stands on the same area. 2½ times 32·5 cM^3 is 81·2 cM^3. If we take the two trees with broadest tubes—those at the bottom of the table with a tube diameter of 20 microns—their yield is $78+99$ $cM^3 = 177$ cM^3, or the average per tree is $177 \div 2 = 88·5$ cM^3. If we add the class with second broadest bore, 19 microns, we find one tree with a yield of 60 cM^3; for the three trees together the yield would average $(177+60) \div 3$ or 79 cM^3, what is already

less than 2½ times the average for all trees. It is easy to read from the tables that including further groups (with third widest tube bore 18·5 microns and so on) will reduce considerably the average yield of the selected trees. Mr. Ashplant says, after having cited the possibility to raise the yielding capacity to 2½ times the one of the present stands, that assuming only ordinary skill and experience and allowing for a few misses one can still safely reckon doubling the present productivity. Yes—if one plants only out of 239 trees in the nursery the two trees with widest bore, less than 1 per cent of the total number. It means, that for doubling the yield we have to raise and to submit to microscopical examination one hundred times the number of plants needed.

If we are less ambitious and use, say 33 per cent of our plants the 79 with widest bore, what will be the improvement? The dotted line in Table IV indicates which plants would be selected then. We can add up their yields and divide the sum by the number; the average per selected tree becomes then 49·5 cM³, or 151 per cent the average for all 239 trees. Under ideal conditions the improvement by planting only 33 per cent of the trees with widest bore would be 151 per cent; in practice it would be, like in the former case, less, certainly well below 50 per cent.

(b) *Sumatra Trees, Common Seedlings.*—Let us now apply the selection of the plants Dr. Frey-Wyssling studied. The tables for his trees are reproduced here in a simplified form and the trees are classified according to tube width. The first set of his comprised 14 seedlings from a native place (Table IV). The average yield for all trees is 6·9 grams. We plant only the 33 per cent or 5 trees, with widest tubes; their average yield can be calculated at 9·2 grams, 133 per cent of the average for all 14. So the selection on tube bore would have improved the yield, but—even if no allowance is made for slips in the practical application—only with 33 per cent, not much more than half the gain with Mr. Ashplant's trees. And to reach this improvement we would have to reject 2/3 of our trees, after examining them all.

Table IV

Common seedling trees in Sumatra classified according to diameter of latex tubes:

Tree Number	Diameter of latex tube in leafstalk	Average yield per tapping In 6th year	Average yield per tapping In 7th year
No. 1	14·4 microns	—	3·3 gr.
,, 5	14·5 ,,	5·0 gr.	5·2 ,,
,, 11	14·9 ,,	5·1 ,,	7·4 ,,
,, 4	15·7 ,,	5·5 ,,	7·0 ,,
,, 2	15·8 ,,	—	2·1 ,,
,, 10	16·2 ,,	7·2 ,,	9·2 ,,
,, 13	16·7 ,,	4·4 ,,	3·6 ,,
,, 9	17·0 ,,	—	3·3 ,,
,, 7	17·2 ,,	6·5 ,,	8·0 ,,
,, 14	17·4 ,,	2·3 ,,	3·3 ,,
,, 8	17·7 ,,	7·0 ,,	6·8 ,,
,, 3	18·2 ,,	6·8 ,,	8·8 ,,
,, 12	18·2 ,,	12·5 ,,	19·2 ,,
,, 6	19·1 ,,	4·7 ,,	7·7 ,,
Average for all trees:	16·6 microns		6·9 gr.
Average for ⅓ of trees with highest yield	17·8 microns		10·6 gr.
Average for ⅓ of trees with widest latex tubes	18·2 microns		9·2 gr.

Table V

Average for all seedling trees, raised from seeds 157 × 185, classifiec according to diameter of latex tubes :

Tree Number	Diameter of latex tube in leaf stalk	Average yield per tapping In 6th year	In 7th year
No. 3	16·1 microns	16·6 gr.	19·2 gr.
,, 5	16·3 ,,	23·1 ,,	28·8 ,,
,, 1	16·4 ,,	15·6 ,,	23·7 ,,
,, 9	17·0 ,,	14·7 ,,	20·0 ,,
,, 6	17·3 ,,	26·5 ,,	32·5 ,,
,, 7	17·4 ,,	22·9 ,,	34·9 ,,
,, 11	17·4 ,,	36·6 ,,	49·3 ,,
,, 8	17·4 ,,	21·9 ,,	32·0 ,,
,, 10	17·7 ,,	24·1 ,,	32·7 ,,
,, 14	17·8 ,,	5·4 ,,	6·0 ,,
,, 4	18·8 ,,	24·4 ,,	34·6 ,,
,, 2	18·3 ,,	12·5 ,,	17·0 ,,

Average for all trees :	17·3 microns	27·6 gr.
Average for $\frac{1}{3}$ of trees with widest latex tubes :	18·0 microns	22·6 gr.
Average for $\frac{1}{3}$ of trees with highest yield :	17·7 microns	37·9 gr.

(c) *Sumatra Trees, High-Class Seedlings.*—Dr. Frey-Wyssling describes also a set of 12 trees, grown from seeds obtained by the artificial crossing of two high-yielding trees (Table V). They are far more productive tban common seedlings; the average yield is 27·6 grams, or four times the average of the last.

If out of these 12 trees we take the $\frac{1}{3}$ with widest tubes—4 trees— and calculate their average yield, we find that it is only 22·6 grams, 5 grams less than the average for the unselected trees. So applying the selection on tube bore would have reduced the crop of our trees, instead of improving it.

The result of selecting the $\frac{1}{3}$ of the trees with widest bore is, that in our case—with Mr. Ashplant's trees—we obtained a maximum improvement of 51 per cent; in another case of 33 per cent and in the third case no improvement, but a lowering of the average crop. These figures show, that the selection on tube width does not stand the proof and that it is certainly not reliable enough to be recommended to the practical industry.

Comparison of the Three Sets of Plants and Buddings.—Besides trying the effect of tube diameter selection on the three sets of trees, we use them also for comparing averages. If there is a close correlation between tube width and yield, we may expect that the groups of trees with same average yield show the same average for the diameter of the latex tubes, and vice versa that if the average of the tube width is the same, the yield will not differ much either. To render such comparisons easy I bave made table VII. For each set of trees we have calculated the average yield and the average tube diameter, at first for all trees, and then for the $\frac{1}{3}$ of the trees with widest tubes and the $\frac{1}{3}$ with highest yield.

Table VI

Comparison of the averages for latex tube diameter and for yields with the groups of trees studied and the effects of the selection in per cent increase:

Ashplant's trees.	Average yield per tapping in grams effect
Unselected	10·8
Sel. acc. t. tube	16·4 + 31 per cent.
Sel. acc. t. yield Sumatra trees, common unselected	6·9
Sel. acc. t. tube	9·2 + 33 per cent.
Sumatra trees, 157 × 165 unselected	27·6
Sel. acc. t. tube	22·6—18 per cent.

The yield for Mr. Ashplant's trees has been calculated from his figures in cM^3 by dividing them by 3 to obtain the yield in dry rubber.

It is curious to state, that there is a marked difference between the common seedlings Mr. Ashplant described and the ones in Sumatra in relation to tube bore, a difference as much as 2·7 microns, nearly 20 per cent of the average. We would not expect this and I cannot find an explanation for it. But, what is still more curious, the average yield is for both sets of trees practically the same. With the large difference in tube bore, no difference in yield corresponds.

If in this case the conditions of environment differ considerably, this factor is eliminated if we compare the high class Sumatra seedlings with the common ones; both are grown under entirely similar conditions. We find, that for the high class plants the tube width is 17·3 microns, only 0·7 microns more than for the common plants, while the yield is 27·6 grams versus 6·9 grams, exactly 4 times the one of common plants.

There again our comparison does not confirm Mr. Ashplant's theory. We find that a large difference in diameter of latex tubes does not correspond with a higher yield, and in the other case, that a very considerable difference in yield does not correspond with a large difference in the average latex tube width.

On the other side, we can compare the average yields of the three classes of seedlings with those of the popular AVROS-Clones. Table VII gives the figures, obtained by Dr. Heusser, in a set of experimental plots now about 10 years under observation.

Table VII

Yield of AVROS-Clones per tapping.

		Seventh year	Eighth year	Ninth year
AVROS	33	27·6	29·9	31·8 grams
	36	24·8	33·2	41·4 ,,
	49	32·5	35·8	34·5 ,,
	50	34·0	29·5	31·1 ,,
	80	25·7	27·8	35·7 ,,

If we compare these yields with the averages for common seedlings and for the ones selected on tube width, we see, that if the latter figures show some improvement, they still remain far behind the averages for the popular clones. Only the high class seedlings come near to these clones in yield, but on this set of trees the tube width selection was a complete failure and further seeds of this high quality are not available.

Apart from the yield there are other characters, like vigour and resistance against diseases, which count, if we want to judge the value of our planting material.

According to Mr. Ashplant (R.G.A., p. 802) he has discovered a number of snags with budding: weak growth, weak renewal, possibly greater susceptibility to disease, undoubtedly greater susceptibility to Brown Bast. Those, who are familiar with our present clones will not share this opinion. On the contrary, we have clones which in vigour and resistance against diseases surpass our common seedlings. There is a special point in favour of budgrafting, compared to seedling selection and that is the great uniformity in special characters.

With seedlings grown from the best selected, clonal seeds, even if *they are obtained by self-fecundation, such a uniformity will never be* reached with our present material. There is a good chance, that some of our clones now popular among planters in Java and Sumatra will show special advantages, for instance a greater resistance against secondary leaf-fall or against drought. If such a clone is found we are certain, that it will *repeat this character in all its buddings*, while with *seedlings* we are never sure we will always find variations in the degree of resistance.

In many circles there is still a prejudice against budgrafting, a lack of faith in the results obtainable by this process.

Instead of arguing with yield figures, I will cite statistical data for Sumatra, where in 1929 practically all extensions were planted with budgrafts, pure and mixed with seedlings.

The Extension with Buddings in Sumatra.—Since 1920 buddings are planted on a fairly large scale in Sumatra. In the first year after 1920 *generally mixtures of buddings and seedlings were planted with the idea* that if the buddings turned out to be less satisfactory, the seedlings only could be kept. Also a fair percentage of the extensions were planted with seedlings, grown from selected seeds, in former years mostly seeds taken from high-yielding trees in common plantations.

At present seeds from clonal plantations become available and possibly selected seeds are now mostly clonal seeds. In the first year only part of the extensions were planted with improved material.

In table VIII we have put together the figures, calculated in acres, for the total extensions of each year and for the average under buddings, under buddings mixed with seedlings and under selected seedlings. From these figures the percentage figures are calculated. They give the percentage of the group of the total extension, the percentage of the total extension with improved material, total of per cent figures column 1, 2, and 3, and the percentage with buddings mixed with seedlings, column 1 + 2.

From these last figures we may conclude, that planters in Sumatra have abandoned entirely the planting of common seedlings; column 4 shows that in the last two years all extensions were planted with improved material. The table shows further, that there is a tendency to turn more to buddings. Column 5 shows a gradual increase in the percentage of the fields planted entirely and partially with buddings. We see further, *that there is a growing confidence in buddings.* The percentage of the extension with pure buddings, see column 1 becomes larger every year.

Table VIII

Figures on extensions with improved material in Sumatra (in acres).

Year	Total extension	1 Pure buddings	2 Budding a seedlings	3 Selected seedlings	4 Improved material	5 Budding a mixture.
1924	22·252	2·580	5·975	4·215		
		11·6%	26·9%	18·9%	57·4%	38·5%
1925	20·630	1·350	11·338	1·732		
		6.5%	55·0%	8·4%	69·9%	61·5%
1926	34·182	8·648	16·432	7·070		
		25·3%	48·1%	20·7%	94·1%	73·4%
1927	40·507	9·758	21·345	9·040		
		24·1%	52·8%	22·3%	99·2%	76·9%
1928	44·257	13·782	23·937	6·537		
		31·1%	54·1%	14·8%	100%	85·2%
1929	32·960	19·340	12·310	1·310		
		58·7%	37·4%	4%	100%	96·0%

Conclusions.—From the figures and comparisons resumed above may be concluded, that the selection average tube diameter in the leafstalk has no value for improving the yields per acre. If we study it from various angles we find that yield and tube width are not so well correlated as Mr. Ashplant thought them to be. In this respect we may cite Dr. Frey-Wyssling's conclusion, that trees with narrow tubes are poor yielders, but trees with wide tubes are by no means always good yielders of rubber. This is a serious drawback against practical application of the method. It is more important for the efficiency of our selection, that we exclude all poor yielders, than that we include all high yielders and it is just on this point that the method fails.

If we apply the method on the three sets of trees, for which yield and tube diameter has been studied, we find that in the two cases, where some improvement was reached, with common seedlings the improved yield remained still far behind the yield which may be obtained with the popular clones.

From this we may conclude, that at present the best way to raise our crop per acre is to plant the best clones now available. That is, what planters in Sumatra have started to do some years ago; from the statistics may be concluded, that they have more and more confidence in buddings. The safest policy for planters in other rubber-producing centres of the world is to follow their example, till perhaps in a further state of the technique of rubber-growing new methods are found, easy to apply, efficient and reliable. I do not think, that the selection on tube diameter responds to those three demands.

NATIONAL BOTANIC GARDENS*

THE principal objects of national botanic gardens may briefly be summarised under the three headings: educational, research, and economic. Perhaps a fourth function of a botanic garden should be mentioned, namely, that of recreation. Any orderly garden performing the functions of education and research, and carrying out certain useful economic services, must necessarily provide a place for pleasure and recreation, for nothing is more beautiful, or provides a more restful place, than a well-kept garden. A garden may, indeed, be a place of recreation, without performing in any noteworthy way any of the three main functions mentioned above, and such, I am afraid, is the case of many gardens which go under the name of botanic gardens.

As regards the educational objects a botanic garden should provide information for all those who wish to learn about plants, not merely their names, which the enquirer should be able to get by an inspection of the gardens, but also the uses of plants, which the officers of the gardens should be able to supply either of their own knowledge or from specimens, or from publications issued by the gardens.

The method of fulfilling the educational function of a botanic garden is therefore by maintaining a classified and named collection of living plants, and also a museum of plant products. Material should be available for the use of teachers in educational institutions, while the public are more directly reached by lectures, and popular publications.

The research activities of a botanic garden should concern themselves with the exploration of the native vegetation of the country; with investigations into its economic possibilities—for instance, the properties of vegetable oils, tannins, timbers, and drugs; with numerous ecological and evolutionary problems such as the effects of changes of climate on plants; with the production of new forms by hybridization or other means; with breeding and crossing to show the taxonomic status of wild plants; and generally with the behaviour of plants under changes of soil.

Most of such work should be done in the garden's nursery section, though many of the plants on view to the public may also be under observation for some specific purpose. In connection with research work a laboratory, herbarium, and library are required. A large botanic garden should produce sufficient scientific material to justify the issue of a regular publication.

The economic value of botanic gardens will be perhaps of most interest, especially to the community among which the funds out of which the gardens are maintained are raised.

Included among the functions of a botanic garden of economic importance are the acclimatisation of useful plants, the distribution and exchange of seeds, the quarantining of imported plants, and the publication of useful information. The gardens should be used for the vocational training of horticulturists, while surplus plants should be available to public institutions.

---

* From a lecture by W. R. B. Oliver, M.Sc., Director, Dominion Museum, Wellington, in the *Journal of the New Zealand Institute of Agriculture*, Vol. 2, No. 4, March **1931**.

Taking the essential idea of a botanic garden as the growing of different kinds of plants in order to study them from either a scientific or economic view-point, then its development must be traced through the early temple gardens, and gardens where medicinal and other useful plants were grown, including especially the garden of Aristotle who was a student of botany. In the 16th century the herbalists began to grow plants for the purpose of study, and from these gardens sprang directly the modern botanic gardens. The first of these appear to be those founded in Italy about 1540, and the first herbarium that founded by Geraldo Cibo at the same time and now preserved in Rome. The idea of establishing public botanic gardens spread rapidly, and before the end of the 16th century there were several such in Italy, Holland, Germany, and France. One of the most important of the early gardens was that founded at Pisa in 1543. The second director of this garden was the famous botanist Andrea Caesalpini, and its influence accordingly spread far. Other early Italian botanic gardens were those of Padua, Florence, and Bologna. The earliest public botanic gardens in other European countries were Leiden (Holland) 1577, Leipzig (Germany) 1579, Montpellin (France) 1592, Copenhagen (Denmark) 1600, Upsala (Sweden) 1627, Oxford (England) 1632, and Marid (Spain) 1763. The earliest Asiatic botanic garden is said to be that at Tokyo established in 1638. The garden at Sibpur, Calcutta, dates from 1787, Peradeniya (Ceylon) 1813, and Buitenzorg (Java) 1817.

In Australia there are some long established botanic gardens that of Sydney dating from 1816, and that of Melbourne from 1842.

The earliest American garden is the Missouri Botanic Garden founded in 1859. The Arnold Arboretum was established in 1872, and the New York Botanical Garden in 1894.

Perhaps the chief educational function of a national botanic garden is the maintenance of a collection of living plants. In the larger gardens this is carried out to the point of growing as many as 25,000 species, as at Kew, named and, as far as the exigencies of space and landscape effect will allow, classified according to their relationships. The Buitenzorg Gardens contain about 20,000 species, and lesser numbers are reported from the other great gardens of the world.

Complementary to a collection of living plants are the collections of dried plant-products forming botanical museums. These may exhibit not only specimens and pictures designed to illustrate the most striking plants of the world but also commercial products derived from plants, such as timber, fibres, dyes, drugs, tanning material, oils, gums, and rubber. Museums are established in all the larger gardens. At Kew there are four museums, in addition to the North Gallery containing 800 paintings of plants and vegetation by Miss Marianne North. At Buitenzorg both botanical and zoological museums are maintained in the gardens.

The gardens and museums are the chief branches of a botanical institution open to the public, and as an indication as to how they may be appreciated, the tally kept at the Kew Gardens may be quoted. This shows that the average annual attendance is about 3,000,000.

Of equal importance with the educational functions of a botanical garden is its research work. For this a staff of trained botanists and chemists is kept in all the larger institutions. Their work consists not only in investigaions on the flora of the country in which the garden is situated, but in the case of the larger institutions the field is practically world-wide. Thus the officers at Kew carried out the preparation of a number of floras of different parts of the British Empire, and for many years sent collectors out to various parts of the world, while the New York garden has a station for plant study established in the Blue Mountains in Jamaica.

In Edinburgh and other gardens are laboratories open to anyone desirous of undertaking botanical research, while all gardens supply on request information on specimens for the use of specialists.

The herbaria established in the world's largest gardens have attained immense proportions, those at Kew and New York, for instance, each containing more than 2,000,000 specimens.

The results of the research carried out by the scientific staff of botanical gardens are published in various monographs and other works and serial publications. Among the larger works may be mentioned the Index Kewensis, which is an alphabetical list of every plant name (other than garden names) published, and is still being carried on by decennial supplements; and the various colonial floras issued by the Kew Gardens. The New York Botanical Garden is issuing an extensive work on the North American flora. The "Revision of the Genus Eucalyptus" published by the Sydney Botanic Gardens may also be mentioned here. The periodicals issued by botanical gardens include such important publications as the following: Kew Bulletin, Curtis' Botanical Magazine, Memoirs of the New York Botanical Garden, Mycologia, Annals of the Royal Botanic Gardens at Peradeniya, and the botanical journals issued by the Buitenzorg Gardens.

The economic work of botanical gardens naturally appeals most to the average person who desires to see some immediately useful return for the money expended in the upkeep of the garden. Such a view is, however, quite a narrow one, as it entirely overlooks the æsthetic, intellectual, and social pleasures derived from the beauty, knowledge, and personal contacts derived from well-kept botanical gardens and from botanical societies. However, as in point of fact the economic interest appeals to a more numerous class than the others, the economic functions of botanical gardens as here defined will be described a little more in detail than the educational and research functions though these are of course, of great economic importance, albeit this may not always be immediately seen. In relation to the economic importance of botanical gardens the following statement made by Mr. Joseph Chamberlain in the House of Commons in 1898 will bear frequent repetition.

> "I do not think it too much to say that at the present time there are several of our important colonies which owe whatever prosperity they possess to the knowledge and experience of, and assistance given by, the authorities at Kew Gardens."

The leading part in the distribution of useful plants to various parts of the British Empire undoubtedly has fallen to Kew Gardens. It was after the appointment of Sir Joseph Hooker, as Director in 1865, that the introduction of new and useful plants to the Dependencies of the Empire and the fostering of new industries in connection therewith was especially made one of the chief duties of the gardens. A great many kinds of useful plants have since been distributed to new centres through the instrumentality of Kew. They include various plants producing fruits—pineapples, bananas, breadfruit; beverages—tea, coffee, cocoa; drugs—quinine, coca; fibres—sisal hemp, New Zealand flax, ramie; besides rubbers, dyes, and timbers.

Both romance and tragedy enter into the story of the first attempt to introduce the breadfruit from the South Sea Islands to the West Indies. In this venture Kew was intimately concerned. A gardener named Nelson was attached to the expedition which set out in the *Bounty* in 1787 under Captain Bligh. One of the objects of this expedition was to obtain breadfruit plants in the Society Islands. After sailing from Tahiti, where the vessel remained for about six months, a mutiny broke out on board

the *Bounty* and Bligh and eighteen others were set adrift in an open boat. After a journey of 3,600 miles the Dutch settlement of Timor was reached, but here Nelson died. The breadfruit was successfully introduced to Jamaica in 1791 with the aid of a Kew gardener, Christopher Smith.

The quinine plant, Cinchona, was introduced from South America through Kew to India in 1860, the seeds being first obtained by Sir Clements Markham. At that time it was costing the Government of Bengal £40,000 a year for quinine. Now a dose of 5 grains can be bought for less than a farthing at any post office, while in England the price is one-sixteenth of what it was then. In Ceylon the Peradeniya Gardens played an important part in the establishment of the Cinchona industry in that country, millions of plants being raised and distributed to growers. It was this industry which helped the planting interests to tide over the period between the collapse of coffee and the establishment of the tea industry.

Rubber is an article of daily use, indispensable in the electrical, motor, and other industries, and up to quite a recent date the world was dependent for the best of all rubbers, the para rubber on natural supplies obtained from the tree *Hevea brasiliensis* in the forests of South America. The seeds are very short-lived, but in 1875 some obtained by Sir Henry Wickham from the forest of the Tapajos Plateau, Amazon Valley, were forwarded to Kew. From these 1,000 plants were raised and sent to Ceylon and the Malay Peninsula, thus establishing the species in those regions.

The above examples briefly summarising the transfer of the breadfruit, cinchona, and para rubber plants from one hemisphere to another should suffice to show the important part that botanical gardens have taken in the establishing of industries in different parts of the world.

It remains now to mention two other functions being carried out by botanical gardens: One is the distribution and exchange of both useful and ornamental plants which is carried out extensively by all national botanical gardens, and the other is the training of horticulturists. Two famous training grounds are Kew, where courses of study are laid out which fit horticulturists, especially for appointments to the botanic gardens of the Empire; and Edinburgh, where the course is free, but anyone not showing satisfactory progress is removed.

Finally, it is worth mentioning that the Botanic Gardens of Adelaide maintains a type-fruit orchard, including apples, pears, plums, and peaches, and from which buds and scions are available to growers.

SYSTEMS OF AGRICULTURE AND THE POSITION OF TROPICAL AGRICULTURE*
PART I

IT has always been taken for granted that agriculture in the tropics has its own peculiar character. This need not be wondered at: the tropical differs very much from that in a northern climate, tropical soils show features not common to our European soils; lack of winter, an abundance of crop pests, and, in a large part of the tropics, an extensive rainfall and high degree of humidity, *all these factors make conditions of plant production different from those* we are used to.

And so as a matter of convenience tropical agriculture was distinguished from agriculture in countries at higher latitudes.

But, when exploring the field of tropical agriculture and its science, one looks for its boundaries, trouble begins. For if "tropical agriculture" does not mean anything more than agriculture in tropical countries, the difference from agriculture in other countries is only a geographical one.

This question brings us directly in contact with the question of the classification of types of agriculture.

Nobody will deny that the ways in which agriculture is practised the world over show very large differences: agriculture in humid west European countries differs greatly from that in the large arid plains of North America and perhaps still more from Chinese and Japanese agriculture. As there are large differences between agriculture in different parts of the world, it must be possible to distinguish different types, each of them practised under certain conditions.

This problem of the classification of types of agriculture has already been attacked several times and from different points of view.

Chevalier gave a system, which he called a bio-geographical one. He points out that ecologists do not seem to take much notice of cultivated *plants and of the influence of culture on native vegetation. But in every* part of the world a very large part of this vegetation has been supplanted by another: either cultivated plants or secondary formations occupying land that had been planted before with one kind of crop or another. He recalls the fact, that the so-called virgin forest of Central Africa is not virgin at all, but largely of secondary formation. Chevaliar concludes his introduction by saying, that in a general way all systems of agriculture which are practised in different parts of the world are adaptations to the existing conditions of topography, climate and natural vegetation and also to the civilisation acquired by its performers.

A study based on this thesis might have produced an important contribution to agricultural geography. But in the classification following this introduction other lines of investigation are followed.

It is in accordance with facts to distinguish between herding and agriculture proper. This last is divided into two groups of systems: extensive and intensive. But with this distinction the classification of Chevalier is not based more on the adaptation to topographical climate and natural conditions, than on conceptions belonging to the domain of farm management.

Every system may be practised extensively or intensively and this is the cause of much confusion. So Chevalier places under the heading "extensive without use of draught animals" both the "rays" system and

---

* By M. B. Smits in *International Review of Agriculture*, Year XXII, No. 2, February 1931.

the periodical clearing of forest on behalf of one or two crops, and agriculture on terraces in the hill country of South-Eastern Asia. But the last often is a very intensive system although no use is made of plough or dung or artificial fertiliser. And tobacco culture on Sumatra plantations, which practise a very intensive system, is based on a short period of clearing, followed by a long fallow in which forest and brush occupy the ground for several years. Systems as different from an agricultural standpoint as Chinese rice culture, plantation culture of perennials, and European agriculture as practised in Denmark, Holland, Belgium, etc. are put together in one division, that of the intensive systems.

Ahrens in 1927 published a study in which he by classification of the agricultural systems tries to show the dependence of these systems on the surroundings in which they developed. According to Ahrens these systems depend on human and geographic conditions. As it is his purpose to show the dependence on the last mentioned, he tries to separate the two influences as far as possible. Therefore he based his study on the different types of landscape (*Landschaftstypen*) Passarges.

Ahrens gives a mass of information about agriculture as practised by native peoples of the tropics and sub-tropics. He arranged it according to the classification Passarges but brought a new principle into account. He divided the agricultural system into two groups, the first not making use of a plough and the second using the plough.

It is not to be wondered at that in these two groups, classified in relation to the landscape in which agriculture is practised, the most divergent types are brought together. Systems differing as much from one another as: primitive agriculture in temporary forest clearings, agriculture in inundation basins after the water has flowed off, grain culture in prairie regions, rice culture on terraced irrigated fields, and agriculture in desert oases, are all put under one heading as not using a plough. His classification becomes still more complicated as he also takes into account in which time of the year crops cover the ground and so distinguishes between: rainy season—dry season—and summer farming and farming the whole year round.

But, does it make any difference in the practice of farming or in its underlying principles, if a forest plot is cleared in the dry season and planted with rice in the next wet one, or by lack of dry season in an arbitrary part of the year?

Also Eckardt and Wohltmann are aware of the influence of natural conditions on the character of agriculture. But the former pays very much more attention to the different agricultural plants and their adaptability to different conditions, than to the agricultural systems of which they form a part. And Wohltmann tries to give a valuation of tropics and sub-tropics according to their productive capacity and classifies them according to rainfall. But he does not indicate how farmers in these different regions managed to get their systems in accordance with it.

When agriculturists have given descriptions of farming of certain areas these have been almost always of limited extent. And although agricultural practice in such areas does not differ so much as in remote parts of the world, they always succeeded in showing the relation between agricultural practice and its surroundings. Many brilliant studies of French, German, and American agronomists show the possibility of a study of this subject based on agricultural principles, and recent English publications on agriculture in the British Isles prove it again. These studies are not concerned with the influence of climatic and other environmental factors on different crops but with the practice of farming and its adaptation to environment.

Agriculture cannot be divided according to a simple set of complementary properties; it is too complicated. It is therefore necessary to ask in the first place, what is the most characteristic farming practice.

It may be asked if it is of more than theoretical value to discuss the question of farming systems. Instead of discussing the question at length it will be hetter to give some quotations from a report of Stockdale on agriculture in Sierra Leone.

After having given a description of existing conditions Mr. Stockdale remarks: "Sierra Leone can be pictured as a country passing through those evolutionary phases which similar wet and undulating countries in the East must have gone through in the eariler stages of their history. Cultivation of rice is passing from the hilly lands after exhaustion to the lower swampy areas. The latter cultivation is the more permanent and should be encouraged. The cultivators can be assisted greatly by lessons which can be translated from the East and it seems very desirable that matters concerned with drainage, terracing, cultivation and regulation of water should he investigated in Sierra Leone." . . . . "Sierra Leone has an indigenous high land coffee, which is of good quality. Liherian coffee does well and the growth of Robusta types is promising. More has to be learned, however, in regard to the cultivation of the latter coffees in Sierra Leone, as such questions as shade requirements and the treatment of the soil have not yet been fully investigated."

In the first quotation Stockdale expresses the idea that experience of Oriental farmers may he of use for Sierra Leone. The lessons of the East should be translated into West African language, that is to say, it should he investigated how far the Oriental farming system could be applied in West Africa and what adaptation to the new country would be necessary. Stockdale does not speak about an investigation of rice, or peanuts, or irrigation, or ploughing, but ahout a certain farming system of which those other suhjects form part.

But to start such an investigation, to translate the lessons from the East, it is necessary to know that Eastern system, to know what characterises it, to know the language of the East.

Stockdale is quite right in borrowing from the East and not from Europe. Europe too is rich in experience, but its experience is of small value for West Africa. It is from the East that the lessons have to come.

It might be useful to point out a difference between the ideas expressed by Chevalier and the advice of Stockdale. In the classification of the former there is place for a "complete system", in which plough, draught animals, fertilising of the soil, etc. have found their place. European agriculture has been the standard by which other systems are measured, being regarded more or less as the ideal system. Stockdale's advice is based on the idea that there is no such thing as an ideal or a complete system. There are several systems, which are of the same value, and each of them may be complete in itself.

The second quotation in regard to coffee-growing does not mention the lessons from the East, hut concerns investigations in relation to shade and soil management. However, it is not European agriculture that will be able to give advice in these matters. Perhaps experience gathered in the practice of tropical plantation agriculture may be of value in this case. But this experience has not much in common with that of the farmer of the Orient. It is another system, differing from Eastern agriculture as well as from European, that will find a place on the hills of West Africa. These few quotations may suffice to show the practical importance of the question of agricultural systems.

Wherever man occupies himself with plant production, either for direct use or to be converted into animal products, his labour and efforts are directed to the establishment of a crop and to the protection of that crop against anything unfavourable to it.

It may be that adverse conditions predominate and that it will not be possible to gain a livelihood in this way. The only method by which it may be gained is then to take the natural vegetation and to convert it into animal products. The aim of the stock farmer is to get sufficient grazing grounds for his cattle and to protect them against adverse conditions.

Both classes may live together in the same part of the country, the arable farmer occupying the localities more favourable to plant production.

It may be that the arable farmer makes use of animals to facilitate his labour, to make it possible to plant a larger acreage, or to get better crops from the same acreage. It may also be more profitable to turn his produce either partly or entirely to his cattle. But this makes no difference in principle: this farmer is occupied first and foremost with crop production.

It may be profitable to the stock farmer to produce crops, to provide food for his cattle when nature does not produce sufficient, and to protect in this way his stock from heavy losses.

Economic and social conditions may change so that it will pay to have more cattle on a certain acreage or more productive cattle, and this may induce the stockbreeder to occupy himself with native vegetation, to ameliorate it and to make it productive.

There is a tendency under certain advanced social and economic conditions to make stock-breeding profitable to the arable farmer and to force the stock-breeder to occupy himself with crop production. The result is that a class of men, formerly not interested in crop production, or only to a less extent now, also becomes interested in it.

The development of agricultural machinery has made it possible to gain a livelihood by crop production where it was impossible to do so before this machinery existed. Large acreages formerly only adapted to grazing are now in use for grain production. Yield per acre is low and uncertain and the old implements did not permit a man to cultivate a sufficiently large acreage to subsist on. New machinery made it possible for the same man to plant a large multiple thereof. And so grazing land formerly only occupied by the stock-breeder has now been added to the grain fields.

But all these alterations have not changed the principles of crop production. Different plants may be cultivated or plants may be grown where they were not before; simple implements may have been supplanted by more complicated machinery, thus enabling men to produce more in the same time, or to do the work more efficiently; the aim is the same to bring the soil into such condition that the plants will thrive and to protect them against adverse conditions.

It has no influence on the growth of plants if the soil is brought into that condition by hoe, or spade, or plough; or if that plough is drawn by animals or tractor. Nor has it any influence or production if weeding is done by hand or by the use of implements or machinery. The only thing that matters is the condition of the soil and if man has succeeded in his endeavour to provide the best condition.

Every farmer knows by experience that yields diminish after his soil has been planted for a certain time with a crop or a succession of crops. This is put down to the soil and it is said that its fertility has diminished. Everywhere one tries to restore that fertility by one means or another. These measures to maintain the productivity of soil form an essential part of every system of agriculture.

We may say therefore that agricultural systems are characterised by:
(a) the condition into which the soil is brought to produce a crop.
(b) the method used to restore, maintain or improve its productivity.

FACTORS OF QUALITY IN COPRA*

WELL-PREPARED copra is white, of low moisture content and brittle, the pieces of copra being of good size and without "smalls". The meat is of good thickness and has a high oil content. If these conditions are satisfied, the copra will arrive in Europe insect and mould free, white and sweet.

Colour.—Besides yielding a colourless oil, white copra also yields a light-coloured cattle cake. Caramelised, superficially burnt, or black copra yields an oil of varying redness which may in some cases be only partially bleachable and a cattle cake which the farmer will reject on appearance and perhaps also because of the smell of associated distillation products from the drying fires. It is also suspected, but not yet confirmed, that insects are especially attracted by slightly burnt copra, particularly where cell rupture has occurred.

Moisture.—Wet copra is the standard product bought by the local dealers in native copra because at certain seasons of the year—notably in November and December—it is impossible to sun-dry copra satisfactorily in this country. During the day the air is about 79 per cent saturated with moisture, while at night the relative humidity averages 95 per cent. Apart also from seasonal fluctuations, humid days and relatively dry days alternate irregularly so that it is impossible to work on standardised lines in order to obtain a standard product either by sun-drying alone or by kiln-assisted sun-drying. Careless preparation therefore, becomes the rule and local dealers adjust their prices accordingly.

In table 1, certain records are given relating to the atmospheric conditions existing in an important coconut district and from these figures an approximate estimate may be made that in the most humid month it takes four times as long to sun-dry copra as during the driest month, while on certain days it will be quite impossible to effect any drying. Thus in the month of November, a piece of wet copra (moisture about 50 per cent) was exposed in the sun for five days by which time it still contained 35 per cent of water and was heavily covered by a multi-coloured mycelium of copra moulds.

To make matters still worse, there is the added factor of heavy moisture generation when such badly prepared native copra is stored under unsatisfactory conditions (see later).

Table I

Atmospheric Conditions on the Selangor Coast (Bukit Jeram)

1929 Mean Hourly Values For Relative Humidity (Day)

Hours	9	10	11	12	1	2	3	4	5	6
July	78	74	71	68	68	67	67	69	70	74
November	86	81	75	74	74	75	76	79	83	88

Mean Values

	Day (10 hours)	Night (14 hours)	24 hours
July	71	88	81
November	79	95	89

	Hours of strong sunshine (daily mean)	Strong windy days
July	8·5 hours	1 day
November	6·4 hours	3 days

Relative Drying Power of Air (Shade)

Assume no drying at about 80 per cent humidity

	Day	Night
July	96 units	0
November	27 units	0 (? with moisture re-absorption)

* By F. C. Cooke, A.R.C.S. B.Sc., Chem. E., in *The Malayan Agricultural Journal,* Vol. XIX, No. 3, March 1931.

At this stage the related question of moisture re-absorption might be considered. While it is claimed for the Philippines that 5 per cent moisture represents approximately the stable moisture content in copra there, the Malayan figure depends on the time of the year and, of course, on the structure of the copra. A skinned over or "case-hardened" copra will naturally take up moisture more slowly than a uniformly dried piece of copra (see later).

It has been found that during the dry season, copra can be dried to 4 per cent moisture content and will remain dry and that wetter copra will on very prolonged storage under good conditions continue to dry out to this figure. In the wet season, similarly well-dried copra will, however. re-absorb moisture slowly to between 6 per cent and 7 per cent for "case-hardened" copra and even up to about 10 per cent for copra which has not a protective skin. About 6 per cent represents the average stable condition of kiln-dried copra stored in bulk. It would materially assist the welfare of the industry and simplify the handling and marketing of this commodity if this figure were adopted as the standard by all producers.

During transport to Europe, all the copra produced in this country dries further and almost invariably on arrival at its destination the moisture content is between 4 per cent and 5 per cent.

To allow for moisture loss and possible deterioration of quality in transit, the usual practice is for the shipper to claim a weight allowance of about 5 per cent whether such a loss occurs or not.

Copra Deterioration.—A copra of satisfactory moisture content, (viz. 6 per cent), is liable only to the formation of a thin white mould which readily falls off in transit, leaving the copra clean and white on arrival in Europe. Copra of higher moisture content produces white, brown, green or heavy black moulds apparently indiscriminately with the development of heat, free acidity, rancid odour and internal darkening of the material. Black mould in particular is indicative of copra with a moisture content in excess of 10 per cent. The factors which determine the development of specific moulds are in course of determination as it is fairly certain that the moisture content is more an agent than a controlling factor.

It is specially intreresting to note that the process of decomposition adds moisture to the copra so that when bad copra is stored in ill-ventilated store rooms or transported in leaky boats, the quality may easily become progressively worse and result in a hot, slimey, dark, evil-smelling, matted product of high acidity but with a high oil content (see table III and later).

Two samples of copra were stored for two months in sealed tins with the following results :

Description	Original moisture per cent.	Final moisture per cent.	Description
White, crisp	4·5	5·4	F.M.S. quality maintained.
White	12·1	64·7	Rank smell. Black, congealed and rotten.

While such slimey copra is of no value of export purposes, it is sold locally at a cheap price and commands a ready sale to certain Malayan oil mills. It is important to explain why such copra contains a high percentage of oil while at the same time heavy losses are incurred during the process of deterioration, both oil and copra being converted to water vapour and gas and lost.

Oil Gradient.—When slices are cut from pieces of coconut meat parallel to the testa or brown skin and the different slices are analysed, it is found that an oil gradient exists in the meat which in the case of ungerminated nuts is practically marked. The figures in table II serve to illustrate this point.

Table II

Oil Gradient in Coconut Meat

Nut Selected	Oil Percentage (dry basis). Slices of equal thickness					
	1	2	3	4	5	Testa
Ripe brown nut	40·0	64·6	67·2	75·8	73·7	13·8
Ripe (1 in. haustorium)	52·0	68·2	72·8	76·0	76·4	—
Overripe (4 in. haustorium)	—	73·8	70·2	74·5	74·5	—

Table III

Copra Deterioration. To illustrate the relation between high free fatty acid (f.f.a.) and high oil percentage.

		Good undeteriorated copra	Insect ridden copra	Mould and insect ridden
Malayan	No. of samples	16	2	8
Estate	Average oil percentage	65·8	65·4	66·8
Copra	Average (f.f.a.) percentage	·1	·2	·8
Straits	No. of samples	6	7	19
Native	Average oil percentage	64·8	65·2	67·0
Copra	Average (f.f.a.) percentage	·3	1·2	1·6

Thus, when moulds attack the inside face of a piece of copra, it would appear as the tissue containing the lowest oil percentage is broken down and removed in the form of gas and water vapour and the unattacked copra that remains becomes progressively richer in oil. As deterioration progresses (in the absence of insect attack) the average oil percentage therefore increases and figures in excess of 70 per cent oil for low grade Malayan copra are quite common. Only in very exceptional cases is the percentage of oil lower than 66 per cent in mouldy Malayan copra, i.e., when copra is uniformly rotten throughout.

During such deterioration, free acidity and the further destruction products of glycerol render the copra sour and evil-smelling and the resulting oil and cattle cake are dark and unpalatable.

However, it is important to note that the ether extract includes the free fatty acid so that deteriorated copra does not contain as much neutral oil as analytical results expressed as oil percentage (dry basis) may appear to show. The importance of this observation lies in the fact that the purification of an extracted coconut oil to remove its free acidity yields in large quantities what is known as "dirty soap stock" and in an edible oil factory the disposal of this bye-product is difficult, while in the soap factory it can only be used in low grade soaps, because it retains most of the dirt and colour of the oil. This soap stock is not of much value and its removal by caustic soda is expensive.

During deterioration by heat, moulds or insects, there is a concealed loss of oil and copra constantly proceeding which may be very considerable. It is the producer who suffers from these causes, because the various buyers allow in the price they are able to offer for anticipated depreciation in transit.

The actual loss of oil and copra occurs during deterioration has been shown experimentally in Fiji by exposing copra on a drying "Vata" to the action of air-borne moulds. In 14 days it was found that the copra dried to 5 per cent but that it lost 12·4 per cent of its anhydrous weight and 8·2 per cent of its total oil, while the free acidity rose from ·2 per cent to 8.5 per cent.

It has been found in Malaya that if bad copra, which has developed a high degree of rancidity, is stored under good conditions of free ventilation, the acidity diminishes while the copra as a whole will become dry and clean and the mould will fall away as dust. Six large samples were stored for three months under excellent conditions and the results are given in table IV.

It would appear that the drying of the copra arrests further acid formation from the neutral oil, while the existing fatty acids are converted into water vapour and gas and removed with a consequent reduction in the (f.f.a.) content.

Table IV

Effects of Storing Native Copra

Date of Receipt : 28-12-29

Original Appearance			Acidity of oil per cent (as lauric acid)			Final Appearance
			30-12-29	28-2-30	18-3-30	
Light brown	Mouldy	Superficial insect attack	·72	·42	·42	All the copra now dry and mould free but exceedingly insect-ridden—originally the samples looked different, now they look similar.
Light brown	Mouldy	Superficial insect attack	1·72	·43	·22	
Dark brown	Very mouldy	Insect-ridden	2·48	1·82	1·51	
Dark brown	Very mouldy	Insect-ridden	3·02	1 21		
Dark brown	Very mouldy	Insect-ridden	3·12	1·76	0 80	
Dark brown	Very mouldy	Insect-ridden	3·43	2·15	2·04	
	Average		2·42	1·30	1·12	

Neutral Oil

Fatty acid	Glycerol
Gas and Water Vapour	Glycerol Derivatives Gas and Water Vapour

Physical Properties.—Apart from its good keeping qualities, well-dried brittle copra is to be preferred because, as has been stated by an authority in England, rubbery copra does not press well. When the pressure is applied the oil flows satisfactorily, but at the end of the operation when the pressure is released, the cake tends to suck up the oil again owing to the elasticity of the material. This authority has stated that with such copra it is not possible to reduce the oil below 7 per cent, whereas good friable copra yields a cake with 5 per cent oil.

Such rubbery copra may be produced from young nuts, and "case-hardened" copra with a wet core will also show elastic properties. It is interesting to note that "case-hardened" copra appears to show considerable resistance to mould attack except in the presence of insects which are able to pierce the burnt crust and so expose the wet copra beneath to mould attack.

Size.—If the pieces of copra are too large, the consignment will naturally be very bulky, and the best practice is to chop the half nuts into four pieces. The manufacturers object to copra of large size on the ground that it takes longer to charge the machinery and more storage room is required owing to the bulkiness of the material.

At this point some reference might be made to the advantages of baling chopped copra. To date, one firm in this country has exported during the past year 500 tons of "F.M.S." copra in baled form to Europe with entirely satisfactory results. An article on this subject giving the experimental results obtained has already been published and further experimental work is proceeding to explore the possibilities of the baling of the lowest grade of copra available on the Singapore market.

It should be noted (a) that copra can be compressed at a pressure of 1·5 cwt. per square inch without loss of oil either during compression or subsequent storing and shipment. (b) That the "broken stowage" is reduced, e.g., 20 cwt. of baled copra occupies only the same cargo space as 12 cwt. of sacked copra. Local transport and shipping freight charges can accordingly be reduced. (c) The bales stock squarely leaving straight channels for air movement through the stack. (d) The bales, which are 2 cwt. in weight, can be easily checked and are of convenient size and shape. (e) There is no evidence that "F.M.S." copra deteriorates more in transit in baled form than in sacks, nor is there any loss of oil.

If the material is much broken up so that there are "smalls" the dealer objects because:

(a) This allows the careless or deliberate inclusion of foreign matter, (grave exception is taken to sand, nails, etc. which can do great damage to machinery).

(b) It makes sorting of "mixed" copra into "F.M." and "F.M.S." grades difficult.

(c) Much broken up copra exposes a large surafce to mould and insect attack and the smallest pieces are gradually converted to a grey fibrous dust which gives the material a dirty appearance. The small pieces are also readily lost in handling.

(d) The cattle cake derived from such copra will be sour and darker than the best.

The production of "Smalls" should, therefore, be avoided and it is recommended that, where the meat must be extracted wet from the shell in the field, as far as possible only fully-ripe nuts should be harvested. The meat of unripe nuts is very adherent to the shell, while the thin meat of very overripe nuts is inclined to break. On the other hand, where the halved nuts are transported to the kiln and are subjected to semi-drying, the half pieces of meat readily fall out of the shell. When the fully-dried copra is subsequently chopped to reduce the bulk, care must be taken to obtain pieces of even size. It is doubtful, however, if this practice is to be recommended as a fresh wet surface is thereby exposed to mould attack. It would be better to chop the copra when half dry as it comes from the shell and then dry and seal the cut surface.

Thickness.—As far as possible, only fully ripe brown nuts should be used for the production of copra because such nuts produce the greatest thickness of dry meat. The practice of picking unripe nuts in order to take advantage of a favourable market, or to obtain a speedier cash return, or because crop collection is leased out, or to anticipate theft, is well known.

Oil Content.—It has been shown that bad copra can contain a high percentage oil content, i.e., high ether extract. At the same time the yield of neutral oil will be small and it will be of low quality on account of extraction difficulties. A large amount of soap stock has to be removed to purifiy the oil, while much of the original colour and odour is still retained in the oil even after refining.

The ultimate objective is to produce a copra equivalent in physical condition, appearance, and oil content to the "F.M.S." Ceylon product. In Ceylon a white copra of high oil content is regularly produced, and receives special preference in the London market. The related questions of cultivation and soil impoverishment are being investigated, while correct nut harvesting and possible oil loss during copra preparation are also being studied with a view to correcting the alleged decline in the oil content of good quality Malayan copra during the last ten years.

SOME FACTORS IN COFFEE CULTIVATION*

Influence of the Acidity of the Cultural Medium on the Coffee Tree.—About the influence of the acidity of the soil on the growth of the coffee tree we are wholly ignorant. The first indications about the requirements of coffee in this respect have been forwarded by the experiments of De Camargo, who cultivated young coffee plants in water cultures of different hydrogen-ion concentration.

As previous experiments had shown, it is possible to cultivate Arabian coffee (*Coffea arabica*) for more than one year in spring water containing 0·0196 K; 0·04 Ca; 0·023 Mg; 0·005 SO_4; traces of H_2PO_4; 0·004 NO_3 and 0·011 C1. In the new experiments sulphate of potash and sulphuric acid were added in different doses so that the cultural solution got hydrogen-ion concentrations of 7·2, 6·8, 5·8, 5·1, and 4·2. After 7 months' growth the weight of the plants, grown in these solutions of different hydrogen-ion concentrations was measured and it was found that the plants grown in the solutions with hydrogen-ion concentrations of 5·1 and 4·2 had obtained the highest weight.

The conclusion may be drawn that *Coffea arabica* prefers a medium of high acidity. It may be expected that the same will be the case with Liberian and robusta coffee and also with other cultivated coffee species. We may remember that the para rubber tree grows well on acid soil with a hydrogen-ion concentration of 3 to 6.

Soils which are suitable for coffee are in general suitable for rubber —in fact the two crops are often grown in combination.

Manuring.—A fertiliser experiment in Porto Rico seems to indicate that on the soil in question a beneficial effect was obtained from potassium manure, especially when combined with nitrogen. The fact that the experiment contains only one series of plots and that each year the arrangement of the plots was modified makes it difficult to draw a definite conclusion. The author considers that in Porto Rico "the application to fairly good coffee of 100 pounds of ammonium sulphate and 200 pounds of potassium sulphate (or potassium chloride) per acre at six months' intervals should bring to the coffee planter handsome returns on his investment in fertiliser." It seems however that further experiments will be needed to give a reliable basis for such a statement.

Selection.—At the Pacific Science Congress, which took place in 1929 in Bandoeng (Java), the question of the selection of perennial crops was one of those discussed. A preliminary report of the paper of Dr. Hille Ris Lambers was given by Ir. Ostendorf.

In Java coffee selection was carried out on one plantation (Banaran) under scientific guidance and in three Experiment Gardens, viz. (1) "Bangelan", the Coffee Experiment Garden of the Agricultural Department, (2) "Soember Assin", the Experiment Garden of the Experiment Station, Malang and (3) "Kaliwining", the Experiment Garden of the Besoeki Experiment Station.

The system in "Bangelan" has been to select superior mother trees and to test the illegitime descendants, (i.e. the descendants obtained by uncontrolled pollination). When a mother tree produced in this way descendants of superior quality, the mother tree was kept for seed winning and

* From the ***International Review of Agriculture***, **Part I, Year XXI, No. 11, November 1930.**

in some cases little fields were planted with grafts of the mother tree in order to obtain a larger quantity of the seeds. Only robusta coffee has been made the subject of a thorough study. In Bangelan the question of the stock has also been studied and it was found that the seedlings of different trees were not all equally suitable for being used as stocks. One hybrid of robusta and Quillou was considered to be exceptionally suitable.

In "Soember Assin" a great number of small fields have been planted with seeds and with graftings of superior mother trees. As far as possible the seeds are obtained by means of self-pollination of the mother tree. Artificial cross-pollination with different mother trees have also been made. The characters which are especially kept in view are: high-bearing power, large beans, and resistance against leaf disease, and berry borer.

In "Banaran" similar lines are followed. Here also mother trees have been selected which excelled in high-bearing power, good quality of beans and resistance against disease, and of each mother tree one or more fields of grafted trees and one field with seedlings—obtained by self-pollination—have been planted.

In "Kaliwining" the same scheme has been followed.

In the discussion which followed after the reading of the papers, it was pointed out that the selection work with coffee had not yet shown the great practical success which the rubber selection work had obtained. One of the greater difficulties in the selection of coffee was according to Ir. Huitema the small amount of graft material that could be obtained from one tree.

Planting System and Shade Trees.—For many years the "dadap serep" (*Erythrina lithosperma*) has been in the Dutch East Indies the generally used shade tree. In consequence of the attack of different diseases and pests (especially of the cicadellid *Typhlocyba erithrinae*) it could no longer be used and was replaced by the "lamtoro" (*Leucaena glauca*). However, neither this nor any of the other leguminous trees tried as shade trees was considered to be equal to the old "dadap." It has therefore been endeavoured in different ways to use the "dadap" again, be it in combination with the "lamtoro."

A new scheme for using the dadap in combination with the lamtoro was proposed by Rudin. This scheme is based on the consideration that the dadap cannot be relied upon after its 8th year, therefore every eight years the dadaps are entirely replanted. This is done in such a way that one half of them are replanted in the 7th year and the other half in the 8th year.

Thus one row of coffee alternates with one row of shade trees, and of the rows of shade trees we have alternating one row consisting of only lamtoro trees and one consisting of lamtoro and dadap alternating. The coffee is planted at 10 by 10 feet, and in the rows of shade trees these are also 10 feet apart. In this way the shade trees are planted very closely, but this is done purposely to make them serve also for the production of fuel, and for this purpose the lamtoro is regularly pruned, while as mentioned, the dadap is replanted after 7 and 8 years. The pruning of the lamtoro is done in this way: every year one-third of the lamtoro is cut back up to 10 feet and in the 3rd, the 9th, the 10th, and the 11th year about one-fourth of all the lamtoros are replanted.

The only drawback of this system seems that it is rather complicated, but the principle to use the dadap in combination with the lamtoro by rejuvenating the dadap every 8 years seems very sound.

The writer also gives a scheme of improvement of the soil conditions by means of a system of pits which are dug between every two shade trees. The system is so that every four years the same pit is dug out again, and in each of the consecutive four years the pits are dug in another place.

A detailed calculation is given of the expenses of the application of this system of shade trees and pits.

Preparation.—An elaborate description of the preparation of robusta coffee in the Netherlands Indies, resulting from an enquiry in which 149 estates collaborated, was given by Knaus.

A minority of the estates use water power, the majority use motor power or steam engines.

As regards the pulping machines the "Vis" pulper has practically ousted all the other systems. (Walker pulper, Gordon pulper, etc.)

Fermentation and washing is done in many different ways. Fermentation time varies from 12 hours to 8 days. It seems desirable to investigate what system is the best and to bring more uniformity into the different methods. On 19 estates fermentation has been entirely eliminated. At any rate it is at present clear that fermentation has no influence on the taste and the colour of the coffee. A too long fermentation can, however, have a deleterious effect.

The most practical washing machine, which is especially recommendable when no fermentation is applied, is the "Rapido" washing machine. It consists of a double perforated trough, in which two horizontal spindles with paddles are rotating. When fermentation is eliminated washing is done on same estates with the addition of lime or ash. This furthers the removing of the pulp. The drawback that beans with a damaged seed skin gets a dark-bluish discoloration makes this method not recommendable.

A new method of fermentation has been tried with success: This consists in fermenting under a slow continuous stream of water. The beans are lying on a perforated plate and water is continually added. In this way the substances which are formed during fermentation are quickly removed and the fermentation is accelerated so that it is completed in less than 24 hours..

When the coffee leaves the washing machine it contains about 55% of water. On the great majority of estates the first drying is done in the sun on drying floors or on a draining floor, or a centrifuge is used. Only on a minority of the estates the coffee is at once brought into the drying house. On the drying floors the water percentage can decrease in one morning to about 35%, if the coffee is spread out in a thin layer; on the draining floor the water percentage goes down to about 50% and in the centrifugal machine to 45%-50%. The higher cost of centrifugal machines makes them not recommendable.

Of the various systems of drying houses the Vis system is the most extensively used. Drying in the drying house is perhaps tbe most important part of the preparation, and the quality of the coffee depends on it for a great part. A drying house is considered to be practically indispensable. On 3 out of the 149 estates no such houses are used: 2 of them dry wholly on drying floors in the sun—a process which takes one week or more—and on one estate a Guardiola drying machine is used. Otherwise Guardiola machines are no longer used on account of their small capacity.

For details of the Vis drying house reference must be made to the original article which gives a scheme of this system. According to the capacity of the house and the quantity of coffee to be dried, drying can be done in a quicker or in a slower tempo. On tbe majority of the estates the coffee is ready after having been kept for 24-25 hours in the drying house. On some estates the coffee remains in it 48 hours. The temperature is on the majority of the estates in the beginning 90-100°C. dropping gradually to 50-60°C. The coffee must regularly be turned over.

When the drying is complete the coffee must be broken either with the teeth or with a hammer and may not be dented.

The tempo of drying influences the colour: slow drying gives a dark-green or even a bluish-green colour, quick drying at a high temperature gives a light colour (yellow-greenish to yellowish). The most desirable colour is obtained by drying at an initial temperature of about 100°C. which is made to drop about 50°C, a greenish colour is obtained in this way and the silver skin gets easily removed, which is not always the case when the coffee is dried slowly.

As to hulling, the Engelberg huller is generally used.

Sorting machines are in use on 46 estates, mostly the Gordon thread-separator. The author considers that better sorting arrangements should be aimed at.

The following figures show the loss in weight of 100 kg. fresh ripe berries during different manipulations:

Fresh ripe berries	100 kg.
Pulped	74 ,,
Washed	52 ,,
Centrifuged	47-49 ,,
Dried on drying floor.	44 ,,
Dried in drying house	26 ,,
Hulled	22 ,,

THE MALARIA PROBLEM OF ASSAM*

IN an address on the control of Malaria in Assam, delivered to the Assam Branch of the British Medical Association in January, 1930, I recorded the principal results of my researches, during the past four years, on Assam's malaria problem. From my researches I stated that *A. minimus* was practically the only carrier found among some 50,000 adults dissected belonging to twenty different species. I also recorded the results of my investigations on the bionomics of this species. I stated that in the selection of its breeding places, *A. minimus* in Nature avoids: (1) Contaminated water. By that I mean muddy or silty water; water with finely divided clay in suspension; water contaminated with the products of iron oxide bacteria; or water covered with a thick scum of surface algae. (2) Water which has a high velocity of current. (3) Water covered with dense shade.

I also recorded that the conditions which this dangerous species selects for breeding sites are: (1) Clear water. (2) Stagnant or slowly movinig water. (3) Where a certain degree of sunlight reaches the water surface.

MASONRY WELLS

To the types of breeding places of *A. minimus* which I have already recorded, I have now to add finding larvae of this species in a "pucca well." The "pucca" well in which *A. minimus* larvae were collected was about 20 feet deep, and was constructed entirely of reinforced stone concrete well-rings cemented together to prevent contamination of the water from percolation. The water level in the well was within six feet from the ground surface. This finding, at first, appeared to me to be exceptional, but the necessary condition demanded by *A. minimus* in the selection of breeding sites, viz., clear, uncontaminated, slowly moving or stagnant water, completely or partially exposed to sunlight, were fulfilled.

The main reason why *A. minimus* and other species of anopheline mosquitoes have not previously heen found breeding in masonry-built wells fulfilling the above conditions in areas which I have investigated is doubtless due to the fact that these wells are usually treated daily with chlorogen, thereby eliminating the larval food supply. Further, mosquito larvae have little chance of surviving even in open unchlorinated pucca wells, as water is being more or less continually withdrawn by buckets from early morning to late in the evening. The well teeming with *A. minimus* larvae had, I found on investigation, been left unchlorinated and undisturbed for several weeks. *A. minimus* has now been eradicated from this well by eliminating the light factor, i.e., by providing a suitable cover. This finding in a masonry-built well clearly demonstrated to me that concrete inverts, unless properly graded and constructed, could also function as breeding places for *A. minimus*. As mosquito control by "pucca drains" was the principal anti-malaria measure adopted in a highly malarious site in Assam, I was interested to learn that many of these drains have also to be regularly oiled because anopheline mosquitoes are found breeding in these concrete inverts. An engineering friend, who has studied the anti-malaria measures which have been carried out in areas under my supervision, wrote to me that "open pucca drains with slopes flatter than 1 in 400 do not keep dry, as slight settlement and imperfect work cause pools to form. At 1 in 400

* By Dr. G. C. Ramsay in *The Journal of Tropical Medicine and Hygiene*, No 23, Vol. XXXIII, December 1, 1930.

they are fairly free from pools. Again, all pucca drains have to be cleaned regularly, as rubbish causes pools." It is obvious that, if concrete inverts *are to fulfil the function intended, the factor underlying mosquito control* by this means is to obtain high velocity of current by eliminating pockets, pools, obstruction from vegetation, and to provide a suitable gradient. In my opinion the gradient should not be less than 1 in 200.

WATER TIDINESS

The removal of vegetation, i.e., the clean weeding of drains, streamlets, streams, pools and tanks has been repeatedly advocated in Assam and elsewhere as an anti-malaria measure. The principles underlying clean weeding or removal of debris which are of value in preventing mosquitoes breeding are: (1) increase of velocity of current through removing obstructions; (2) in certain types of soil there is increased water contamination from the direct action of the water on the denuded soil surface (silt or clay factor); and (3) in other cases and especially in pools and tanks the removal of vegetation diminishes the available shelter for larvae and increases the opportunites of larvivorous fish. But my own experience has been that *A. minimus* will breed freely in the small pockets and bays of clean-weeded, clear water, slowly running drains, streamlets or streams, also in clean-weeded pools or tanks if the degree of light, demanded by this species in its breeding areas, is sufficient. In high-lying hyperendemic malarious sites the slow flowing clear water in loops, pockets and pools of partially shaded or unshaded streams and streamlets affords prolific breeding places of *A. minimus*. These areas are frequently devoid of any vegetation (grass or weeds) near the water edge. It is apparent therefore that clean weeding as an anti-larval measure has decided limitations, especially as thorough oiling by a knapsack sprayer destroys vegetation. Further the decomposing vegetation is an excellent medium for retaining oil.

In most tea estates in Assam it is routine custom to clean out ditches and drains periodically from the point of view of tea cultivation. The principle underlying cleaning drains is obviously to prevent water logging, or in other words to increase soil aeration by facilitating run-off. The result of these cleaning efforts, unfortunately, has been in many cases to broaden water channels unnecessarily, and thereby to reduce the velocity of current also to increase the difficulty of providing biological control of malaria by dense shade.

SHADE

Where feasible, water channels on malariogenic terrain should be narrowed and deepened as this increases the velocity of current and facilitates covering by dense shade. Dense shade, of course, prevents vegetation from growing in the bed or on the banks of a drain or streamlet and hence obviates the necessity of cleaning these channels, thereby also eliminating the recurring expenditure associated therewith. During the past eighteen months I have been investigating the degree of shade essential to eliminate *A. minimus* from proved breeding places. I find that durantha (the thorny privet hedge) and eupatorium give excellent dense shade over narrow channels and have, so far, from my investigations, fulfilled requirements, but my recommendation to shade clear-water broad channels with trees such as *Cassia nodosa* or *Cassia javanica*, unfortunately limits itself only to certain types of breeding places. Cassia trees although they give dense shade are deciduous and hence will not fulfil the function intended over breeding areas which are malariogenic during the period of the year when the leaves have been shed. Cassia trees shed their leaves in March, April, and early May, hence these trees are only suitable for shading breeding areas which function as *A. minimus* resorts, during the monsoon season. In hyperendemic sites where malaria is being transmitted after

the night temperatures rise above 60°F. in March and April, it is essential, where feasible, to provide dense evergreen shade over water-courses which are selected by *A. minimus* as breeding sites during this period of the year. For this purpose I am at present carrying out experiments with trees which will give dense shade throughout the entire Assam malaria season. The jak-fruit tree (*Artocarpus integrifolia*) appears to be highly suitable for this purpose.

SWAMP VEGETATION

A clear distinction must be drawn between the planting of swamp vegetation and allowing a swamp to revert naturally to jungle. I have watched swamps in the process of reverting to jungle over a number of years, and during these years they have remained a deadly danger to all who lived near them. In parts of the swamp there is shade enough to retard the growth of larvae; but the shade was by no means uniform, and open spaces teeming with *A. minimus* existed. In the course of many years, the probability is that the whole swamp would be shaded over; but we cannot afford to wait this time.

The vegetation I am now planting consists of several swamp plants, which are not the end-product of reversion to jungle, but an intermediate stage. They propagate themselves rapidly when introduced, and as we know from practical experience soon blot out the sunlight and *A. minimus*, which requires sunlight.

In these hyperendemic sites the principle underlying absolute shade are also being applied; that is filling in functionless man-made drains, man-made clear-water tanks, and borrow-pits.

TEMPERATURE

I have previously stated (*Ind. Journ. Med. Research*, 1930) that during the period of the year (December, January, and February) when the night temperatures drop below 60°F. the feeding stimulus of anopheline mosquitoes and especially of *A. minimus* is inhibited.

With a view to reducing expenditure on larvicides I stopped all anti-larval measures on fifteen gardens under my supervision during the past season when the night temperatures had dropped below 60°F., but carried on, as usual, all anti-larval measures on three tea estates in the same district, so that the effect on the incidence of malaria could be compared on controlled and uncontrolled areas during the ensuing transmission period. Fifteen of the uncontrolled gardens included three hyperendemic sites, while two of the controlled areas were also hyperendemic sites. The results, so far, have shown that, if dangerous breeding areas are efficiently controlled by anti-larval measures during the period of the year, when the night temperatures rise above 60°F., it appears to be unnecessary to apply anti-larval measures during the non-transmission period of the year. Further investigation, however, is required to confirm this opinion.

SOIL COMPOSITION

The relationship between soil composition and the breeding of *A. minimus* has been of great interest to me during my researches. The importance of certain types of soil which cause water contamination and hence become free from *A. minimus* is clearly brought out in low-lying land in Assam. In studying drains, streams, and streamlets on high-lying land it is interesting to note that many of these channels which have dried up during the cold dry weather run silty during the first few showers of the North-West monsoon and then clear during the remainder of the rainy season. The silt in these channels is obviously mainly due to atmospheric action, during the cold dry weather, which causes soil disintegration. As

soon as the gross products of disintegration have been washed away the water in these channels again runs clear and forms ideal breeding places for *A. minimus*. On low-lying cultivated land the finely divided products of soil disintegration, which have been in the past and which in this changing universe continue to be carried down from high-lying to low-lying land, are easily stirred up by rainfall and are inimical to the breeding habits of *A. minimus*. During the cold dry weather of 1929-30 I carried out a series of experiments on a drain, about fifty yards in length, on low-lying land, which *A. minimus* had selected as a cold dry-weather resort, because the undisturbed water had become clear. The silt was stirred up in the centre of the drain by three of my establishment for two hours daily over a period of one week. This had apparently no effect on the number of larvae which could be caught in the clear-water pockets at the edges. These pockets were unaffected as the silt did not reach them, but when the pockets and grassy edges of the drain were stirred up for two hours daily over a period of a week it became extremely difficult to find a single *A. minimus* larva. The degree of silt, also of water contamination generally necessary to eliminate *A. minimus* requires further investigation as experience has shown me that *A. minimus* is sometimes compelled during the cold dry weather to accept types of breeding places which are avoided during the rainy season when there is a great increase in the number of more suitable breeding places.

RICE FIELDS

An extensive cold weather breeding area, formed by seepage from a plateau adjacent to a tea estate where the spleen-rate, in garden-born children, has never in my experience been over 6 per cent. has also been of great interest to me. This area is free from *A. minimus* during the period of the year when the soil is stilled and when under rice cultivation. As soon as the rice crop is reaped, in November and early December, the undisturbed exposed seepages teem with *A. minimus* larvae. Water contamination from silt during the rainy season and probably the shade of the thickly planted rice after the monsoon season appear to be the factors in keeping this area free from *A. minimus* until the rice crop is out.

Many of the swamps in Assam when cleared are harmless owing to their soil composition (silt or clay factors); but exposed clear-water swamps are invariably highly malariogenic. The danger of these swamps is in many cases further increased when railway embankments or bund roads cross them and retard the flow of the natural waters and so increase the bearing areas. Instead of the usual bund and narrow bridge or culvert, screw bridges or suspension bridges are much more satisfactory. Such bridges cause the minimum interference with nature, and facilitate the replanting of the swamp with aquatic vegetation that will ultimately completely eliminate sunlight and *A. minimus*.

Again in Assam there are thousands of acres of swamp where, owing to the composition of the soil, rice can be safely cultivated. But in other places, swamps are so deep, and of so little value for growing rice, that it is questionable whether it would not be better to abandon them, and move the people back a safe distance, which need not be far, as was shown by Watson's observations on flat land jungle in Malaya, and Christopher's on the Andaman Islands. Both these observers found that malaria was absent, or nearly so, in villages or estate cooly lines which were over half a mile from the breeding places of *A. umbrosus* and *A. ludlowi* respectively. Even if further research fails to show us more efficient methods of controlling anopheles than we now possess, we have always the above as a method to fall back on.

EFFECT OF MALARIA ON LABOUR

Investigation has shown me that malaria in Assam is the disease which is mainly responsible for reducing the efficiency of, also for depleting, tea garden labour forces. Experience has also taught me that it is the highly malarious tea estates which are mainly compelled to recruit labour. There are many tea estates in this Province which are practically free from malaria and which have not recruited labour for over twenty years owing to the natural increase in the population. I have been informed that annually over £500,000 is spent by the tea industry on recruiting labour to tea estates in Assam from other Provinces in India. Much of this annual recurring expenditure will doubtless in due course be saved by the tea industry when the malariogenic factors in each area are carefully investigated and appropriate anti-malaria measures applied.

SUMMARY

A. minimus, which is the main vector of malaria in Assam, was found breeding in a masonry-built well. This finding, at first, appeared to be exceptional but the necessary conditions demanded by *A. minimus* in the selection of breeding sites were fulfilled.

This finding also shows that *A. minimus* will breed in concrete inverts if these are not properly graded and constructed, i.e., mosquito control by concrete inverts is dependent on velocity of current. In the case of masonry-built wells the light factor has to be eliminated by providing suitable covering.

In certain highly malarious sites it is essential, if *A. minimus* is to be eliminated, to shade malariogenic water by trees which will give dense shade throughout the entire Assam Malaria Season.

MEETINGS, CONFERENCES, ETC.

BOARD OF AGRICULTURE

FOOD PRODUCTS COMMITTEE

MINUTES of the meeting of the Food Products Committee of the Board of Agriculture held in the Board Room of the Department of Agriculture, Peradeniya, at 2.30 p.m. on Monday, the 23rd March 1931.

Present.—Hon'ble Dr. W. Youngman, Director of Agriculture (Chairman), Messrs. C. Drieberg, A. A. Wickremesinghe, S. Pararajasingham, A. Ramalingam, C. A. M. de Silva, Gate Mudaliyars A. E. Rajapakse and M. S. Ramalingam, W. A. Udugama Dissawa, Rev. Fr. L. W. Wickremesinghe, the Entomologist, the Economic Botanist, the Divisional Agricultural Officers, Central, Northen, North-Western, and South-Western Divisions, and Mudaliyar N. Wickramaratne (Secretary).

Visitor.—Mr. L. S. Bertus, Assistant in Mycology.

The Chairman announced that letters and telegrams were sent by the following members regretting their inability to attend the meeting: Hon. Mr. A. Mahadeva, Messrs. H. L. de Mel, C. W. Bibile, E. C. de Fonseka, C. Muttiah, the Agricultural Chemist, Gate Mudaliyar G. A. Gunatilake, and Mudaliyars G. W. Gunaratne and S. Muttutamby.

The minutes of the meeting held on 4th August, 1930, were confirmed.

Before proceeding with the business of the meeting, the Chairman referred to the absence of two members who intended to lead discussions on certain items in the agenda and to the poor attendance at meetings in general, and said that if it was found that the interest of members was falling off, it would become necessary to ask Government to reduce the number of meetings for the year which was four, but he hoped that that would not be necessary and it would be possible to keep the Food Products Committee going up to the full number of meetings.

With reference to the minutes of the previous meeting, the Chairman informed the meeting that the Sub-Committee appointed to go into the question of the reports made by the Paddy Sub-Committees and to draft recommendations, submitted the following to the Board of Agriculture at its annual Conference held in October last, viz:

"In presenting to the Board of Agriculture, in Conference, the reports of the Local Committees, the Food Products Committee recommends, through the Sub-Committee appointed for the purpose, that a Commission be appointed by Government to enquire into, and make recommendations with regard to, the possihilty of increasing paddy production in the Island in the light of the information in the reports, and it recommends especial attention, among other points, to the following:

(1) Improvement of irrigation facilities so as to meet the needs specified in the reports.

(2) Organisation and co-ordination of the services concerned with the cultivation of paddy as Agriculture, Irrigation, Revenue, Forestry, Animal Husbandry and any others (here should be considered provision of pasturage and fencing).

(3) Tenancy conditions (consolidation of infinitesimal shares in land, alienation of new lands under such conditions as to prevent the system of infinitesimal shares, and the impediment of the existing share system of rental).

(4) The marketing question (credit, supply of seed paddy and manure).

(5) Anti-malarial and other public health measures.

(6) The improvement, where necessary, of means of communication.

(7) Provision of efficient drainage and flood protection, including the clearing of elas."

Mr. H. L. de Mel, a memher of the Sub-Committee recommended the insertion of the words "at an early date" between the words "recommendations" and with regard to". Mudaliyar Samarasinghe signed the above recommendations with the following rider:

"I subscribe to the above without implying therehy that I consider the suggested recommendations adequate action upon the reports."

Mr. Wickremesinghe added the following rider:

"That elucation in village schools be in a decidedly agricultural trend and experimental paddy plots be provided for every village school."

The Chairman further stated that on the suggestion of Sir Herbert Stanley, the Board of Agriculture bad agreed that the recommendations of the Sub-Committee of the Food Products Committee be accepted in the main. A Paddy Commission had already been appointed and had its first sitting. The terms of reference had already been published.

AGENDA ITEM 2

NOMINATION OF MEMBER FOR N'ELIYA DISTRICT

The Chairman announced that Mr. M. B. Wettewe, Kachcheri Mudaliyar, had been nominated a member of the Food Products Committee to represent the Nuwara Eliya Food Production Committee in place of Mr. C. B. Herat.

AGENDA ITEM 3

ENCOURAGEMENT OF EXTENSIVE GROWING OF FRUITS

The Chairman said that Mr. H. L. de Mel who was to move the motion standing in his name for discussion viz:

(a) to follow up the campaign for a more intensive growing of fruits;

(b) to organise a freer distribution of budded and grafted fruit plants for sale;

(c) the manuring of fruit plants with a view to obtaining the fruit out of season;

had written to him of his inability to attend the meeting and had forwarded a memorandum on the subject which the Chairman said he would not propose to read but would like to place at a meeting at which Mr. De Mel would be present. The Committee agreed to allow the motion to stand over.

AGENDA ITEM 4

ASSISTING THE PADDY COMMISSION

The next motion in the agenda submitted by Mr. De Mel viz:

"What steps this Committee should take to assist the Paddy Enquiry Commission which has been appointed"

was also allowed by the Committee to stand over.

AGENDA ITEM 5

INCREASE OF THE DUTY ON IMPORTED RICE

The Chairman called upon Rev. Fr. Wickremesinghe to move for discussion the motion standing in his name viz:

> "That the duty of imported rice be increased to help the paddy cultivation which has received a heavy set-back owing to the present low prices of imported rice."

Rev. Father Wickremesinghe expressed a desire that that motion be referred to the Paddy Commission and that was the wish of the Committee.

The Chairman here explained the procedure adopted by the Paddy Commission in their working and suggested that a discussion of the subject might be useful to the Commission.

Rev. Father Wickremesinghe explained his motion and dwelt on the unprofitableness of the paddy cultivation. The price of local paddy had gone down to Re. 1/- per bushel owing to the low price of imported rice which was Rs. 10/- a bag and suggested that the local paddy production should be protected by the raising of the Customs duties on imported rice.

He contended that if the price of paddy were to fall further there was danger of paddy being put out of cultivation. Many a cultivator in the Hambantota District who had been cultivating paddy was now preferring chena cultivation. He suggested the raising of the import duty on a sliding scale in proportion to the fall in the price of imported rice so that the price of paddy would correspond to that of imported rice.

A general discussion took place in which the following took part: the Chairman, Messrs. Drieberg, A. A. Wickremesinghe, De Silva, Pararajasingham, Peiris, Haig, Gate Mudaliyar Rajapakse and Udugama Dissawa.

The Chairman in a lengthy statement explained the position of the paddy industry. He said that if a tax were to be levied on imported produce, it was generally necessary to fix a maximum rate for the article. In the event of any interference with a thing of this sort it was necessary that the whole industry should be strictly controlled. This was a drawback. The Paddy Commission would no doubt consider the possibility of an import tax.

The Chairman was of opinion that the world depression in many things was undoubtedly related to the price of cereals, the food of the main bulk of the world's population. The condition of things in Russia, he said, was one of the many disturbing factors operating in the markets of the world. The Chairman remarked that a matter that should be closely considered was whether the depression in the price of cereals, including rice, was of a permanent or temporary duration. The problem was the same in Siam, Burma, and other paddy-producing countries. The return from rice in Siam was quite insufficient to make it not worth while growing. The Chairman believed that the Burmese to some extent attributed the depressed condition of rice to the almost absent competitor among the few exporting firms. He did not doubt that a good deal of economic depression was due to the fact that industries were in too few hands. This was one reason for the depression in coconut products. He said that coconut oil was mostly used in the manufacture of butter but the margarine trade in the world lacked healthy competition being in the hands of only a few firms. The Chairman remarked that whether permanent or not, the depression in the price of paddy made it impossible to produce rice at a profit not only in Ceylon but also among the Burmese from whom Ceylon procured her rice. In such a case rice production in exporting countries

would stop and ultimately the pendulum must of necessity swing the other way. The Chairman remarked that if paddy were to go out of cultivation, something else would have to be grown for the subsistence of the peop'e and what that was going to be was not easy to say.

Another important point to consider was whether Ceylon would see a great increase in the production of food grains or vegetables. One thing that the Chairman had remarked was that Ceylon was in the very extraordinary position of being perhaps the only civilized nation in the world that had no industry apart from agriculture and that her agriculture produced no product of an annual crop or pasturage. The Chairman expressed his anxiety as to what would be the economic result if there was a drop in the value of tea when rubber had gone and coconuts were going. The cash coming into the Island would then have decreased considerably and the fate of Ceylon was to be seen, a country not producing enough food for itself nor any commodity apart from those three plantation products that it was sending out with which to derive its cash. Ceylon, he said, was in a unique position in which no other country in the history of its economic development had ever, been. He concluded that the result would be far-reaching if Ceylon forsook paddy cultivation.

Mr. A. A. Wickremesinghe thought any increase of taxation would be felt by the poor and particularly by the estates where the labourers depended entirely on imported rice. It was, he said, the low price of rice that saved the estates. He was opposed to the proposal.

Mr. Pararajasingham agreed with Mr. Wickremesinghe and said that it was dangerous to interfere with the natural law of consumption and production. He pointed out that the price of paddy in the North was between Re. 1-75 and Rs. 2/- and advocated better method of milling rice and adoption of modern methods and intensive cultivation in order to increase the yield.

Mr. Drieberg said that it was a dangerous experiment to raise the duty on rice and particularly so he thought as Ceylon was hoping to get India to consent to a reduction of import duty of Ceylon coconut. The only alternative was to subsidise paddy cultivation by allowing a bounty and this was also not practicable owing to the state of finances.

Rev. Fr. Wickremesinghe, in replying to some of the criticisms, said that if there was no increase of production of paddy it was due to the lack of irrigation facilities. As regards the contention that the increase of duty would affect the estates, he said that when the tea and rubber producers were making money during booms the paddy cultivator never did.

Mr. Pararajasingham thought tbat paddy cultivation was only a side line and Mr. Drieberg pointed out that it was not so in Fr. Wickremesinghe's district but it was the main industry.

Mr. De Silva thought that they were not justified in increasing the import duty in order to procure some benefit for a small section of the community and Fr. Wickremesinghe protested that his motion did not contemplate a tariff.

The Chairman remarked that it seemed to him that the reduced cultivation of paddy in the South might be an indication of the fact that the cultivators were taking to dry grain cultivation more permanently than in other parts of the Island. He thought that this was influenced by several economic factors and it might lead to the growing of cereal crops, cotton, maize, and legume in rotation. He further opined that dry cultivation has not made more advance and that the agricultural implements were very primitive.

Gate Mudaliyar Rajapakse opposed the proposal as it would affect the consumer who was poor. He recalled the fact that the proposal to fix a minimum price of paddy at Rs. 3/- per bushel during the rice crisis was abandoned by Government. He suggested Fr. Wickremesinghe to withdraw his motion, but the Chairman thought that it was not necessary as it was only a suggestion.

Udugama Dissawa said that if the import duty were to be raised the poor will suffer and opposed the motion. He further said that the Kandyan villager did not grow paddy as a business proposition but he did so because he considered it a disgrace to eat imported rice.

Mr. Haigh (Economic Botanist) said that he could not see how the paddy industry in Ceylon could derive any benefit by protection as Ceylon was not self-supporting in paddy.

The Chairman in concluding the debate said that the discussion had been a most interesting one and had presented the subject in a new light to several of them. He had no doubt that some of those present at the discussion would present Fr. Wickremesinghe's view to the Paddy Commission and that the Paddy Commission would carefully consider the same.

AGENDA ITEM 6

AGRICULTURAL INSTRUCTORS TO HELP AND INSTRUCT THE PEASANT CULTIVATOR

Rev. Fr. Wickremesinghe moved for discussion :

> "That the Agricultural Instructors stationed at the different agricultural centres be attached primarily to help and instruct the peasant cultivator rather than be wholly occupied with the Farm Station"

and in doing so he said that for many years there had been Agricultural Stations and Agricultural Instructors had been placed in charge of them but the cultivators were not taking any help or advice from them. Villagers looked upon the Agricultural Stations as very good things but they were short of finance to follow the methods adopted in these Stations. He therefore suggested that Instructors should go from village to village and instruct and advice villagers. He also thought that the Instructors similarly should visit schools and impart knowledge which the children could acquire and take back into their village and put into practice.

The Chairman, Messrs. Peiris, Wickremesinghe, Drieberg, Gate Mudaliyars Ramalingam and Rajapakse, Mr. Harbord, and Mr. Pararajasingham offered remarks.

The Chairman said that that was a very interesting motion and observed that Fr. Wickremesinghe was six months behind the times; the Agricultural Instructors and the Divisional Agricultural Officers had been given emphatic and explicit instructions on those lines suggested by Fr. Wickremesinghe, and he expected that these instructions should be carried out by all those officers. He said that the Instructor at Tissa in the Father's district had definite instructions about his work and he had been given manure and seed paddy for distribution to villagers, and he hoped that the Father in his parochial visitations would come across him before long.

Mr. Peiris (Divisional Agricultural Officer, South-Western) gave detailed account of the work done by himself and his Instructors in experiments with fertilizers, green manure, and seed selection.

Mr. Wickremesinghe enquired about the work done in connection with school gardens and the Chairman explained, and said, to achieve still better results closer co-operation between his and the Educational Department was wanted.

Mr. Drieberg said that the School Gardens Scheme was a success at the beginning and the Chairman jokingly remarked that that was about the time that Mr. Drieberg was responsihle for the work.

Gate Mudaliyar Ramalingam testified to the good work done by the Instructors.

Gate Mudaliyar Rajapakse desired to grow new improved types of paddy suitable for Negombo and Messrs. Haigh, and Harbord promised to supply him with necessary information as regards suitable varieties such as B 13 or A Podiwi B 11, A 8 etc. The discussion closed.

AGENDA ITEM 7

THE UTILITY OF PADDY SEED STATIONS

Mudaliyar Muttutamby who was to have moved the following motion viz:

> "Means to increase the utility of Paddy Seed Stations and demonstration plots"

was absent and discussion of the motion was postponed.

The Chairman said that he intended visiting Mannar to see what could be done. He remarked that Mr. Muttutamby wanted a greater impression made on village cultivators and if Mr. Muttutamby would show the Department how it could be done, it would be of immense help to the Department.

Mr. Pararajasingham referred to the remarks made by the Chairman about the poor attendance and suggested the revival of holding of meetings in Colombo and Peradeniya alternatively. Mudaliyar Ramalingam said that for Jaffna members, Colombo was a more convenient place for meetings. The Chairman explained the difficulty of getting a suitable place for holding meetings in Colombo and asked the Secretary to see what could be done.

N. WICKRAMARATNE,
Secretary,
Food Products Committee.

VIEWS AND REVIEWS

SOIL EROSION IN CEYLON*

SOIL erosion is a world-wide problem and is increasingly attracting the attention of governments. A summary of present-day knowledge of the causes and effects of erosion and of preventive measures has recently been issued as Technical Communication No. 5. by the Imperial Bureau of Soil Science. It shows that little experimental work has been done and that data are required regarding the incidence of rainfall, and the amount of erosion caused thereby, the effectiveness of the various methods proposed for the conservation of water and soil and the extent to which soil characters are an important factor in determining erodibility. It points out that erosion forms the subject of publications from India, Ceylon, South Africa, New Zealand, Nyasaland, many parts of the United States, and several European countries. It is already the subject of legislation in various parts of the world and its urgency as a national problem in the United States of America is shown by the recent appropriation of 160,000 dollars (Rs. 450,000) by the Federal Government for research into its causes and means of prevention and into the conservation of rainfall by terracing and other means.

The problem in Ceylon has recently been investigated by a Committee representative of revenue, agricultural, irrigation, forestry, survey, and planting interests. The existence of serious soil erosion and the possible consequences thereof have been pointed out by scientific experts, agriculturists, Irrigation and Forest officers, since the time of Sir J. D. Hooker (1873). Largely as a result of statements made in the report of P. M. Lushington on Ceylon Forests Sessional Paper XII of 1921) the present Committee was set up to consider the question of soil erosion in all its aspects.

The Committee made exhaustive enquiries into the state of affairs existent in Ceylon by visiting all the important planting districts and inspecting agricultural works, irrigation works, village settlements, and forest clearings. In each district it held enquiries at which planters, revenue officers, headmen, and representatives of the Irrigation, Public Works, and Railway Departments were invited to be present. It also met representatives of agents and proprietors of estates of all kinds. Its evidence was collected by the use of questionnaires to which written answers were obtained and by informal discussion at enquiries.

The present state of affairs in Ceylon is stated in some detail. Tea, rubber, and coconut estates, small holdings, village settlements, chena cultivation, and forest clearings are considered *seriatim* and the measures taken to combat soil erosion on each of these forms of cultivation are enumerated at length. The external evidence of erosion in the silting of estates and paddy fields, the damage to irrigation works, roads, and railways, the silting and flooding of rivers is also described.

* Report of the Committee on Soil Erosion. Celyon Sessional Paper III of 1931. Government Record Office, Colombo.

A section is devoted to an account of the attitude of agriculturists towards the question of soil erosion, as evinced by the evidence heard at enquiries. While it is to be regretted that several prominent agriculturists did not give the Committee the benefit of their experience, although more than one opportunity to do so was given to them, the majority of the planting community showed the greatest interest in the problem and discussed it fully and at length. It was found that on the whole the seriousness of the problem was realised, but that the realisation was by no means always translated into action. A variety of causes was responsible for this inaction. The prohibitive cost of adequate measures of soil conservation was urged by some; the lack of encouragement to spend money on works that did not show an immediate return in increased yields was given by others as a reason for the non-extension of preventive measures against erosion. Objection to the use of ground covers was perhaps the commonest cause of the inadequacy of existing measures of soil conservation. The vexed question of clean weeding was much discussed; the Committee put forward the suggestion that ground covers, were of the greatest importance in conserving soil and in preventing erosion; with that suggestion a majority of witnesses agreed, but contended that ground covers had disadvantages which outweighed any benefit that they might confer in the prevention of erosion. Upon further examination it was found all too commonly that the so-called disadvantages were founded largely on prejudice, and that the indictments against ground covers were difficult of proof.

The views of the Committee form the subject of a separate chapter. It is first laid down as an axiom that "soil erosion is caused primarily by the free movement of water on the surface of the ground". Accepting the truth of this axiom the report considers critically the measures of soil conservation enumerated in a previous chapter, and approves or condemns them by the efficiency with which they prevent the free movement of surface water. Judged by this standard, ground covers become of *supreme importance and are considered by the Committee to provide the* key to the solution of the problem of soil erosion. The objections that have been raised to the use of ground covers are discussed and are shown to be largely the result of prejudice or ignorance. Soil treatment is considered to be of importance if properly done, but shade, terraces, and leguminous hedges are only of limited value. Ideas of drainage systems stand in need of drastic revision, and drains should be regarded as a second line of defence against soil erosion rather than as a means of leading the water off the land by the shortest and quickest route. The tendency of recent years to flatten the gradient of drains should be encouraged, and the provision of silt-pits and locks and steps is essential if the drains are to fulfil their proper functions of holding up the water until a maximum amount may be absorbed and of removing from it any silt which other means of soil conservation may have allowed to be removed.

The present methods of treatment of new clearings leave much to be desired, and the Committee urges that more consideration shall be given to the crop in what is perhaps the most critical stage of its existence. The prevailng idea appears to be to establish a record time in which the crop may begin to yield, rather than to establish favourable conditions for growth from the beginning and to give the young plant a good start in life. There is no denying that commercial considerations must enter largely into estate practice, but a policy that considers immediate returns first and the health of the crop second is a short-sighted policy.

Educative propaganda is considered to be urgently required for the dissemination of modern ideas of soil conservation among small-holders and village cultivators; education in the possibilities of permanent rotation in dry areas is expected in time to reduce the area of land under chena cultivation, and to reduce thereby the damage done by this wasteful form of agriculture.

The recommendations of the Committee follow naturally from the views outlined above. The Committee considers that estate agriculture is responsible for a very large part of the erosion that is in progress in Ceylon, and that the first step that should be taken to combat the erosion should be the provision of ground cover. It recommends that education and propaganda should go hand in hand with research into methods of soil conservation; at the same time it holds that the safeguard against erosion that it has enumerated are so basically sound that they should be adopted at once and that their advantages will be confirmed by further investigation. It considers that education of small-holders and village cultivators should be the concern of the institutions devoted to agricultural research and above all of the revenue officers, whose co-operation is essential for success.

The question of legislation for the enforcement of measures of soil conservation received the serious attention of the Committee. Its first opinion on seeing the appalling wastage of soil that is in progress was that Government interference was called for; further consideration of ways and means and appreciation of the good work voluntarily done by agriculturists in recent years, led the Committee to re-consider its views and to divide the problem of soil erosion into two parts, those of external and internal damage. Without depreciating the significance of internal damage (i.e., damage to the land which is being eroded) the Committtee has decided that, until the possibilities of propaganda, persuasion and example have been exhausted, it is not desirable to recommend Government interference with private property; it considers, however, that the subject should be reviewed in five or seven years' time, and that if the improvements that are hoped for as a result of publication of the report have not taken place, compulsion by means of legislation should be considered.

The Committee considers that there is no justification for external damage (i.e., damage to property other than that on which the erosion is taking place). It recommends that steps should at once be taken to introduce legislation or to amend existing legislation so that those who damage others' property by the injudicious exploitation of their own land should be penalized, and that public departments should have power to insist on preventive measures where it is patent that external damage will occur as a result of proposed agricultural operations.

RUTHERFORD'S PLANTERS' NOTE BOOK*

RUTHERFORD'S Planters' Note Book, of which the 9th edition has recently appeared, needs no introduction to the planters of Ceylon. The first edition was published in 1887, and the book has been ever since the standard reference work on planting and allied matters.

The addition of an advertisement to the cover has distinctly detracted from the appearance of the 9th edition.

On turning the cover the absence of a preface is noticed, so that not even a general acknowledgment is made to the numerous authors whose publications have been freely used throughout the book.

A table of contents indicating the subjects of the chapters would be a useful addtion.

The first three cbapters deal with land and survey, machinery, and buildings, and undoubtedly contain some of the most useful information in the book. These three chapters have been enlarged by 7, 14 and, 29 pages respectively, and, though much of the new matter is of undoubted value, there is a stage at which such material by increase of volume tends to lose its value as a reference work for the layman and assumes the character of a text-book for the expert.

The beading of the next chapter is Miscellaneous" and it contains information on subjects as diverse as the removal of stains from clothing and the number of "Quadraat Duim" in a "Quadraat Voeten". It is an open question whether this chapter is needed. The general information can be found in a reference work such as a popular encyclopaedia, while the tables of weights and measures might perhaps be included in the chapter on land and survey, which already contains a number of such tables.

The chapter on labour contains an excellent and lucid summary of the system of recruiting now in force, the organisation of the Department of Indian Immigrant Labour and the Ceylon Labour Commission, and the general status of Indian labour on estates.

The chapter on tea lays itself open to a good deal of criticism, both as to balance and arrangement, and as to the selection of the matter inserted.

In dealing with the opening of tea clearings it is to be regretted that no mention is found of the possibility of contour planting, while the general question of soil erosion is largely ignored—the word erosion, in fact, does not even appear in the index! It is hoped that the 10th edition will contain extracts from the report of the Committee on Soil Erosion.

The statement on page 262 as to the toxic effect of grass must at least be considered as "non-proven."

In the sections which describe the operations of centring, it is noted that no mention is made of those methods of bringing young tea into bearing advocated by Mr. John Horsfall and others, although these methods have in the last few years achieved considerable publicity.

The section on manuring might perhaps be of more value if sample mixtures were quoted or, at all events, the quantities of nitrogen, phosphoric acid, and potash found in representative mixtures.

---

* *Rutherford's Planters' Note Book*, 9th Edition. The Times of Ceylon Co. Ltd., Colombo, 1931. Rs. 20/- (s. 30/-).

The section of green manuring is one of the most disappointing in the book. If "Buildings" and "Medical" are worth 103 pages each, surely green manuring is worth more than 2 pages ? Apart from its inadequacy, this section contains some questionable statements. Both *Gliricidia maculata* and *Indigofera endecaphylla* (which is misspelt " endecopilla") are included in a paragraph headed *Shrubs*. This same paragraph of two and a half lines contains three spelling mistakes and three cases of the wrong use of capitals.

The paragraph on creepers mentions *Vigna oligosperma* and *Vigna hosei*, though these are one and the same plant, and its correct name is *Dolichos hosei*.

After the general article which is found at the beginning of the chapter a number of publications, or extracts from publications, of the Ceylon Department of Agriculture are inserted. It is obviously impossible to include publications dealing with every phase of tea planting and it is suggested that a preferable method would have been to enlist the services of an expert to contribute a concise article on each principal subject (as has been done in the case of rubber diseases). The officers of the Tea Research Institute suggest themselves in this connection—but the existence of the Tea Research Institute is not even mentioned in the book.

Moreover the publications chosen for inclusion do not always seem the most suitable. Thus, in dealing with Shot-hole borer, the whole or portions of publications issued in 1903 and 1918 are included but no mention is made of Bulletins 56, 72, or 78, published in 1922, 1925, and 1926 respectively. Again all the publications included deal with insect pests; diseases are somewhat inadequately dealt with in two pages, which incidentally contain further misspellings.

Manufacture is lucidly and concisely dealt with in a single article—the name of the author is not given.

The chapter on rubber starts with an interesting general article by Mr. E. C. Villers which is followed by extracts from Garnier's *Ceylon Rubber Planters' Manual*. In this chapter it is thought that the question of cover crops is not given the prominence it deserves. Only one ground cover plant is mentioned.

The inclusion of Mr. Denham Till's lecture on methods of opening rubber clearings is a wise step.

The wisdom of the selection of Department of Agriculture publications in this chapter may again be questioned. Bulletins 55, 68, and 77 all deal (under different titles) with the correlation between yield and various vegetative characters in a certain plot of rubber on the Experiment Station, Peradeniya. Extracts from Bulletin 68 are first given, then, after plunging into a number of other subjects, extracts from Bulletin 55 (the earliest one) are given twenty pages later. Bulletin 77 (the latest) is not mentioned at all. The other publications quoted are in some cases very old and more up-to-date literature on the same questions exists in plenty.

The section on manufacture starts with *The Occurrence of Bubbles in Sheet Rubber* followed by other extracts from publications dealing with problems of manufacture. One would have thought that a general description of manufacture would be a more appropriate beginning, but this only comes ten pages later when extracts from O'Brien's *Preparation of Plantation Rubber* are given. Practically all the information on rubber manufacture necessary for a book of this kind could have been obtained from this booklet and that the inclusion of Mr. L. M. W. Wilkin's article on smoked sheet which, though an excellent article, obviously goes back to the early days of sheet, was scarcely necessary.

The tables showing the percentage of profit on a rubber property at varying capital and yields will probably be hurriedly passed over in 1931.

The article on budding contains much interesting and useful information, though one or two statements call for some comment. Allusion is made to the choice between "seedlings and stumps" as stocks. Apart from the fact that the "Stump" so alluded to is a seedling, in practice a stumped seedling is practically never used. Again a geneticist would probably not accept as complete the statement that uneven results are obtained from planting seed of one tree because of "the varied pollination that takes place"; Self-fertilisation would not eliminate the mixed genetic heritage of the tree. Rejuvenation is dealt with, but complete replanting is not mentioned, though this is now usually considered the best course. The name of the author of this section is also not given.

Mr. Murray's comprehensive survey of rubber diseases is of the length and character desired for inclusion in a work of this kind. .

The chapter on coconuts is perhaps rather better balanced than those on tea and rubber—possibly because a less bewildering array of technical publications exists.

The chapter entitled "Cultivation and Manuring", contains much valuable information. Being of a general character it is suggested that it might be better inserted *before* the chapters dealing with particular crops.

The next chapter is headed "Planting Diseases and Pests". As these have already been dealt with under the crops concerned one wonders what the contents of this chapter is to be. Actually the chapter contains an account of one pest only (termites), and no diseases; the remainder of the chapter is occupied with plant pest and disease legislation. The latter is a most necessary inclusion but if a chapter under this heading is to be included, it would possibly be better to have relegated *all* accounts and publications dealing with pests and disease to this chapter. Alternatively all diseases and pests might be included under the chapters on the crops to which they chiefly apply and the legislative portion might be transferred to the later chapter on legal matters.

The chapter on medical matters is most comprehensive, but here again the particular precedes the general: the chapter starts with a description of hookworm, while some pages later are found sections entitled *"Simple Rules of Health"*, and *"How to Avoid Diseases"*.

The chapters on the diseases of animals, electricity, and book-keeping all gain in conciseness, lucidity, and value from a lack of multiplicity of authors.

Rutherford's Planters' Note Book has been of unquestionable value to generations of planters but it is certain that its value could be greatly enhanced and, at the same time, its bulk considerably reduced by better balance and arrangement, by more specially written articles by experts, and by a more judicious selection of literature to be included.—T.H.H.

AN ECONOMIC VIEW OF RUBBER PLANTING*

THIS is an unpretentious booklet written by one who apologises for not being a planter, but a banker. The author seems to have travelled through rubber-producing lands and to have made and recorded first-hand observations. The book is interesting especially because of the notes upon matters connected with the rubber industry in some countries that may not have been realised by those resident in another. Some of these notes are of a nature that will especially interest those concerned with rubber in Ceylon. For this reason it is intended here to give a synoptic review of the book not with the idea of obviating one from the necessity of purchasing it, but rather to whet the appetite to read more.

The author possesses a vein of optimism as to the future of the rubber-growing industry such as is certainly not shared by all, and he still thinks "that the industry has a very bright future." He blames the "Stevenson Scheme" for much of the present depression. "Artificially maintained prices induced the native of Sumatra and Borneo to plant new gardens. Had *not the price been raised in such an abnormal way, the native* would never have planted over 1,000,000 acres in a few years, as rapid extensions require capital and native cultivation always proceeds slowly in normal circumstances."

"The surface under rubber in the Dutch East Indies should therefore now reach nearly 1,200,000 ha. (3,000,000 acres) against 500,000 ha. in 1923, i.e., an increase of about 15% in five years—thanks mostly, it may be said to the "Stevenson Scheme".

A table is given of the acreages planted by the leading companies in Malaya :

	Acres
"Dunlop Rubber Plantations, Ltd.	85,000
S. I. P. E. F. (F. M. S. Rubber Co., and other subsidiaries)	80,000
Société Financiére des Caoutchoucs (several companies, but under the same general manager)	28,000
Malayan American Plantations, Ltd.	24,000
Malacca Rubber Plantations, Ltd.	22,000
Anglo-Java Rubber & Produce Co. Ltd. ...	23,000
United Sua Betong Rubber Co., Ltd.	22,000
East Asiatic Rubber Co., Ltd.	23,000
Penang Rubber Co., Ltd.	16,000
London Asiatic Rubber & Produce Co., Ltd ...	11,000
Linggi Plantations, Ltd.	10,000
Straits Rubber Co., Ltd.	10,000
	354,000

"In Malaya, generally speaking large companies own a fair number of average-sized estates (from 2,000 to 3,000 acres) under the supervision of a general manager and visiting inspectors. There are very few large estates in one block, an exception being the Dunlop Plantations, Ltd., which are now planting about 12,000 acres in one block. Almost all these companies have their Head Office and Boards of Directors in London".

* "An Economic View of Rubber Planting" by R. Soliva. Kelly & Walsh, Limited, Singapore. 2$. 50 cts.

"The organization of small estates of a few thousand acres is generally this: First of all, many are not quite independent, but are more or less under the control of agency firms which keep their accounts, sell their rubber in Singapore or London and often supply them with a manager and a visiting agent. The agents are frequently interested in the estates holding more or less important blocks of shares and having a seat on the Board."

"In Java there is a large number of small companies" and "Sumatra is the land of the largest rubber companies in the world".

The areas of the leading Dutch East Indies companies are thus given:

	Hectares
"Société Financiére and subsidiaries (Soengei Liput Cult. Mij. Asahan Cult. Mij., Batangara Cult. Mij., etc.)	26,000
Ruhber Cultuur Mij. Amsterdam (R. C. M. A.) ...	24,000
The Hollandsch Amerikansche Plantage Mij. (H.A.P.M.) and associated companies, a suhsidiary to the General Rubher Co.	23,500
Harrisons & Crossfield (United Serdang, Central Sumatra Rubber Estates, Etc.)	19,500
Deli Batavia Rubber Mij.	8,000
The Goodyear Orient Co. (a subsidiary to the Gooodyear Rubber Company)	8,500
Deli Mij.	5,500
	115,000

1 hectare = 2½ acres."

In Ceylon "no large companies are to be found possessing 5,000 or 10,000 acres as in Malaya and the Dutch East Indies. But a few groups control rather a large number of small estates totalling several thousands of acres".

"It seems to be the general opinion of European planters that low-lying lands are not suitable for growing rubber. Yet in 1929 in the F.M.S. the average production of native estates was estimated at 500 lb. against 400 lb. for European estates. I personally visited a large number of native gardens and was much surprised at the high yield of their trees, which undoubtedly confirms the accuracy of the statistics.

It is however difficult to conclude anything definite on the matter for the two following reasons:

1. Native estates are generally planted with 200 and even 250 trees per acre, while European ones have generally from 80 to 100 and are certainly under-planted.
2. Native estates allow secondary growth between the trees, and generally lie on very flat land; consequently they do not suffer much from erosion. On the contrary European estates situate on hilly land, have lost most of their top soil, thanks to "clean weeding".

"It is very difficult to ascertain the area under budded rubber, for there are numerous estates which have budded a few scores of acres, and no statistics whatsoever are available.

I know personally of about 30/40,000 acres which will be budded by the end of 1930.

If one supposes there are some further 30/40,000 acres budded on large plantations and on small extensions of middle-size estates, one would estimate the budded area at some 70,000 acres (about 30,000 hectares) corresponding to about 5% of rubber under European or American ownership in British Malaya".

"It is noteworthy that in this respect the Dunlop Plantations, Ltd. are far in advande compàred with other companies. They appear to have been among the first to start budding on a large scale in Malaya, under the supervision of a Dutchman, Dr. Cramer, who formerly was one of the Heads of the Agricultural Department in Buitenzorg.

One of the most interesting facts of the opening of the Dunlop Plantations, is that they have bud-grafted some 6,000/7,000 acres of trees, some of which were 2½ years old. I could see that the results were very satisfactory and I noticed the same thing at the Pasak Rubber Co., which is now bud-grafting about 2,000 acres from one to three years old."

"Practically all the estates turn out smoked sheet or crepe, as usual, with the exception of some estates which use new processes. One of these is the "Sprayed Rubber Process" of the Malayan American Plantations (a subsidiary to the General Rubber Co., of New York), used by the H.A.P.M. and the Anglo-Dutch Plantations of Java, in the D.E.I.

The other which appears to be the more interesting is the concentration of latex by the centrifugal process in use on the Dunlop Plantations, Ltd.

Latex is thus concentrated to 60% rubber content instead of 30 to 35% in its natural condition and shipped to Europe in tins or barrels. All the latex however cannot be concentrated this way and in fact, about 10% remains which has to be turned into crepe. What makes the process of special interest is that the buyers in London pay for concentrated latex, 40 to 50 per cent. more per lb. dry, than for standard crepe, owing to the saving they realise in its use."

Some interesting notes are given upon the health conditions of the labour force on rubber estates.

"The opening of new estates has always been very unhealthy, and Malaya has been no exception to the rule; but the matter has been taken in hand very efficiently by the Government with the help of the planters, and results may be considered very satisfactory.

About 1911/1912 the death rate on estates varied from 4% to 6%. In 1927 it was 3%, and in 1928 2·9%, which means a decrease of nearly one-half. These last figures are very near the averages for towns or rice-fields.

How were these results obtained ?

Although coolies suffer from many diseases such as hookworm, dysentery, etc., the most dreadful one is malaria, and this has been fought by every possible means.

The disease is carried from one cooly to another by the anopheles mosquito and there are two ways of fighting it : isolation of sick coolies or destruction of carriers.

Conversely to what has been done in the Dutch East Indies, efforts have been mostly directed towards the destruction of mosquitoes rather than to the isolation of sick coolies.

A thorough investigation of the habits of anopheles was conducted from 1900 to 1910 and revealed three main kinds of harmful species in Malaya : *A. ludlowi, A. umbrosus,* and *A. maculatus.*

Though the matter has been much discussed for long in Malaya, it may be found of interest to say a few words about it.

A. ludlowi lives in marshes and swamps and in brackish water, often near the sea. It is generally easily controlled when the soil is dried by open drains. As however European estates are very seldom located on the alluvial coast, they are rarely affected by this mosquito, but rather by *A. umbrosus* and *A. maculatus.*

The former lives in the jungle in the shade. It generally disappears when the jungle is cleared and open drains are dug. But when *A. umbrosus* is controlled, then appears *A. maculatus* which lives in running water exposed to the sun. It has been very difficult to eradicate it; yet estates have succeeded in controlling *A. maculatus* through sub-soil drainage or oiling; but they are expensive methods.

Owing to the high cost of anti-malarial works against *A. maculatus*, the tendency is now to concentrate European bungalows and cooly lines within a circle having a radius of 400/500 metres which is extensively drained and oiled and to do nothing or very little in the other parts of the estate. This method is being adopted by the Dunlop Plantations, Ltd., for their new openings."

The author has a keen appreciation of the value of scientific research and bud-grafting. Speaking of the rubber in the Dutch East Indies he says:

"A typical character of the large estates, with one exception, is the importance devoted to research departments which employ large staffs, and work in very close connection with the AVROS., the well-known Planters' Association of the East Coast of Sumatra (Algemeene Vereeniging van Rubber Planters ter Oostkust van Sumatra)."

"One cannot too much emphasise, in my opinion, the leading rôle played by these research departments, and nothing is more demonstrative of their usefulness than the awkward position of the companies who have been planting with ordinary material for the last few years and whose plantations will be almost valueless in five or ten years, unless they bud immediately their trees, even if they are three or four years old".

"But the most important fact as regards new planting is the budding of rubber trees which is now universally considered in Sumatra as having left the experimental stage. Most estates have already budded their new openings for several years, without inter-planting them with seedlings, as was done heretofore as a measure of safety in case of failure of budding. Besides, some companies are now tapping somewhat large budded areas (probably several thousands of hectares) and tbe results appear so far to meet expectation."

"It is at present difficult to ascertain the practical results of bud-grafting, as the oldest fields planted with buddings came under tapping only six months or one year ago. Anyhow it may be of interest to know the following facts:

A few hundred hectares, six years old belonging to the RCMA (Rubber Culture Mij. Amsterdam) has yielded about 900kg. (810 lb.); 20 ha. of the HAPM (the Hollandsch Amerikansche Plantage Mij.) planted nine years ago is said to yield 900/1,000 kg. per ha; a small area of the same company covering only 3 ha., and seven years old, is said to give 1,400 kg. per ha.

Further, I will recall, it is now generally admitted that the first clones of AVROS numbers 49 and 50, will give 4 to 4½ kg. (8 to 10 lb.) and the newly-proved clones such as AVROS No. 152, Bodjong Datar Nos. 5 and 10, Prang Besar, Tjirandji, will yield from 8 to 10 kg. (15 to 20 lb.) In fact the aim of some large companies like the RCMA and the HAPM, is to plant with trees giving 8 to 9 kg. (17 to 20 lb.) per tree, corresponding with 300 trees per ha. to a theoretical yield of over 2,500 kg. per hectare.

Though such yields will not be practically reached, yet productions of 1,000 kg. or even 1,200 kg. per ha. (900 or 1,100 lb.) appear quite reasonable, as ordinary trees giving about 2 to 2½ kg. (4 to 5 lb.) yield on a good estate 450/500 kg. per hectare, with 200/250 trees per hectare."

"Very interesting efforts are made, on one side, to improve the preparation of rubber and ship a produce easier to work than sheets, and, on the other, to reduce the cost of milling.

The HAPM have established a very large central factory which can turn out yearly 18,000 tons of liquid latex and sprayed rubber, coagulated by heat instead of the usual acid.

The RCMA is trying also to ship a liquid produce called "revertex" which is latex concentrated by evaporation up to 70-75% of dry rubber.

It is very likely that many other improvements will be introduced in the future, for companies are devoting more and more attention and money to mills in their provisions for new plantations. I should add that this will be one of the most efficient weapons against native and Chinese producers who (as in the case of sugar and palm oil) will never be able to compete in the scientific field."

With regard to average yields in the various producing countries the author's comparison is not so full and certain as we should like. He complains of the difficulty of estimating, being due to variation in restriction assessments in the different countries during the "Stevenson Scheme". The average production for Malaya in 1929 is worked out at 410 lb. per acre against only 356 in Ceylon, although the three previous years' averages are given as 280 lb. and 270 lb. respectively.

The average yield per acre for Java in 1929 is given as 393 lb. and for Sumatra 381 lb. and average for the three previous years works out at 359 lb. and 355 lb. These figures are certainly very different from the beliefs held by some.

It is difficult to understand why in the comparison of costs of production in Sumatra and Malaya in the table on page 81 income-tax should be added in each case, but on page 104 in the comparison between Malaya and Ceylon income-tax is omitted from the Malayan expenditure and the cost of production reduced accordingly.

The author's method of treating costings is somewhat algebraical. Although the formulae are readily understandable when one follows their deduction yet their employment in synoptical tables involves considerable back reference to see what the symbols do mean.

We do not however wish to depreciate the value we have found in this publication. We advise all those interested in rubber to procure the book—and read it.

LABOUR PROBLEMS OF CEYLON*

THIS small and inexpensive book, printed and published by Frewin & Co., Colombo, will be found of value and interest to all employers of labour who have the welfare of the labouring classes at heart. In it the author has endeavoured to analyse the present position as it relates to both estate labour—and non-estate labour. With regard to estate labour, of which by far the greater and more effective part is composed of Indian immigrant labourers and their descendants, emphasis is given to the fact that "living in" and working conditions have greatly improved in recent years, but that general conditions for local labour do not compare so favourably.

The many aspects of labour questions have been ably emphasised in this book, a perusal of which makes one realise the complexity of the labour problem in Ceylon, and the great necessity for serious study in the elucidation of these problems.—G.H.

---

* *Labour Problems of Ceylon*, by S. E. N. Nicholas, Frewin & Co., Colombo Price Re. 1-50.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 30th APRIL, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	240	67	41	160	24	15
	Foot-and-mouth disease	470	254	414	3	52	1
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	2*	...	...	...	...	2
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	211	18	181	8	22	...
	Anthrax (Sheep & Goats)	11 †	2	...	11	...	...
	Rabies (Dogs)	2	...	...	...	...	2
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Cattle Quarantine Station	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax (Sheep & Goats)	88	9	...	88	...	...
Central	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	14	...	14	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	6	...	...	...	...	6
Southern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1039	7	986	5	48	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Northern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Black-Quarter						
	Rabies (Dogs)						
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Surra	5	5	...	5	...	...
North-Western	Rinderpest	6537	2582	74	5689	60	714
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	2421	522	327	1854	171	69
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	1	...	1	...	...	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	...	...	...	...
Sabaragamuwa	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	41	41	17	...	24	...
	Anthrax	...	...	...	...	...	...
	Haemorrhagic Septicaemia	18	13	...	18	...	...
	Piroplasmosis	1	...	1	...	...	...
	Rabies (Dogs)	1	...	...	...	...	1

* 1 case in a cow. † 2 cases amongst cattle.

G. V. S. Office,
Colombo, 8th May, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

APRIL, 1931

Station	Temperature: Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Humidity: Day	Night (from Minimum)	Amount of Cloud	Rainfall: Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo	88·6	+0·5	75·8	+0·3	74	93	7·0	9·40	22	+ 0·53
Puttalam	89·4	+0·3	76·1	+0·9	75	91	4·6	5·17	9	- 0·33
Mannar	91·1	-1·0	77·5	-0·2	74	89	4·0	3·66	9	+ 0·75
Jaffna	89·2	-0·1	80·8	+0·3	76	85	3·8	2·85	7	+ 0·82
Trincomalee	89·2	-0·3	77·9	+0·6	74	89	3·6	2·35	6	+ 0·24
Batticaloa	88·5	+0·2	76·3	+0·4	78	95	5·6	3·49	4	+ 1·56
Hambantota	88·0	+0·7	76·2	+1·5	74	91	4·0	11·91	12	+ 8·58
Galle	86·9	+0·9	76·9	+0·5	78	91	5·7	11·43	15	+ 1·75
Ratnapura	92·1	+2·4	74·2	0	78	93	4·9	14·95	24	+ 2·63
A'pura	92·6	+0·9	75·1	+0·6	66	95	6·2	10·35	12	+ 3·59
Kurunegala	92·7	+0·7	75·0	+0·8	68	93	6·7	11·00	17	+ 1·09
Kandy	88·4	+1·4	70·4	+0·6	72	95	6·2	8·13	22	+ 1·31
Badulla	84·1	+0·1	67·2	+1·6	80	97	5·8	14·08	23	+ 6·69
Diyatalawa	78·3	+0·9	61·7	+1·6	76	92	6·2	17·69	23	+ 11·92
Hakgala	74·5	-0·7	56·6	+2·7	80	94	5·6	11·78	27	+ 4·52
N'Eliya	71·4	+0·1	50·5	+2·6	78	97	6·6	11·35	24	+ 5·72

Thunderstorm activity was exceedingly well marked in April and several cases of damage by lightning occurred. The accompanying rain was above average over the greater part of the Island, though deficits preponderated in the W.P., the N.W.P., and the western part of Sab.

The rainfall was in excess over most of the main hill country, and particularly so along its southern limits, the chief contribution to this being on the 14th, when both the Hospital and the Railway Station at Haputale recorded over 9 inches, while over 8 inches was recorded at each of West Haputale, Blackwood and Diyatalawa P.W.D., while further north Rangala and Kobonella both reported over 7 inches. Falls of between 5 and 7 inches were far too numerous on that day to refer to individually, though mention may be made of heavy rain further south on the 29th, when Mawarella had 7 inches and Morawaka 6½.

The highest totals for the month were 35·4 inches at West Haputale and 30·6 at Blackwood. West Haputale's figure is a record for any one month at that station, while at most places in the neighbourhood this month's total is the highest on record for the month of April. In the case of Diyatalawa, where figures for 31 years are available, it is 67% in excess of the next wettest April.

All stations throughout Ceylon reported some rain, and very few reported less than a couple of inches.

A squall at Colombo on the 27th was noticeable, both on account of a velocity of 69 miles per hour recorded at the Pilot Station, and because of its extreme localisation. In the Fort, immediately south of the harbour, the velocity was much weaker, while at the Observatory it was under 30 miles per hour.

Temperatures and Humidities were both rather above average, while, despite the rain being generally in excess, the same was true of the duration of sunshine.

Indications for the ensuing season are not very definite. The slight correlation afforded by the thunderstorm activity of April suggests less rather than more, than the usual rainfall at western up-country stations for May-September inclusive.

A. J. BAMFORD,
Superintendent, Observatory.

The

Tropical Agriculturist

June 1931

EDITORIAL

THE PADDY COMMISSION AND THE PRICE OF RICE

THE Paddy Commission appointed by Government has commenced its labours and divided itself up into three Committees to study the subject deputed to it under the terms of reference. These Committees concern themselves with (1) irrigation, drainage and communications, (2) tenancy, credit and marketing, and (3) the possibilities of influencing the situation through rural education and uplift.

There are some who are asking at this stage why with foreign rice so cheap there is need at all to consider paddy production in Ceylon. This is a very specious argument. It is poor consolation to the man who has not the wherewithal with which to purchase and whose sole stock in trade is human energy.

The continued purchase of a foreign product can only be a feasible economic proposition, even if the price be below that of the local article, so long as the money sent out of the country for it is brought in by the sale of some other commodity.

The past condition of affairs in Ceylon agriculture has only been rendered possible by the fact that, although he might not have realised it, the Government official, the office clerk, the banker, the merchant, the baker, the candle-stick-maker earned their wherewithal in the majority of cases, directly or indirectly, from one of the main plantation industries tea, rubber or coconuts. When as at present serious calamity is overtaking these important industries and the worker must of necessity find his labour in less request, never matter what may be the price of foreign rice, it is a policy of the soundest nature to produce and consume to the utmost extent home-grown food grains.

A nation's ability to win in the race for progress depends entirely upon the amount of struggle that it can put up for existence. The need to see how this struggle can be helped and encouraged to continue is now greater than ever in spite of the low prices for foreign rice. These are the duties of the Paddy Commission and such duties are as imperative now as they ever have been if indeed not more so.

PADDY NOTES (IV)

(A) AN IRRIGATION POT EXPERIMENT
(B) THE VIABILITY OF LONG-AGED PADDIES

L. LORD, AND W. N. FERNANDO,

DEPARTMENT OF AGRICULTURE, CEYLON

(A) AN IRRIGATION POT EXPERIMENT

IT has been found in California that continual submergence of rice fields from an early stage in the growth of the plants has a very definite effect in preventing weed growth. This was confirmed at Peradeniya. It appears that if the fields are submerged before the weeds (mainly *Cyperaceae* with *Fimbristylis miliacea* are probably the most important) are tall enough to reach the water level growth is prevented and the plants eventually die. It has been noticed also that the weed growth in fields unavoidably kept dry in the early stages has been profuse. Where it can be practised, therefore, continual submergence of rice fields offers a method of reducing weeding costs or alternatively of securing a better yield without weeding. Continual submergence, however, can only be carried out where water is plentiful and bunds are sufficiently high and impervious. Moreover, it has been stated that the drying of fields, which perforce takes place in many districts in Ceylon during the growth of the crop sometimes to such an extent that cracks appear in the soil, encourages root development and is therefore beneficial. With the object of obtaining information on this point pot experiments were laid down at Peradeniya in the *yala* season of 1929 and the *maha* season of 1929-30.

The experiments were carried out in cement pots whose inside measurements were 12 in. square and 14 in. deep. Regulated drainage was provided at the bottom of the pots. Precise irrigation experiments under field conditions necessitate the construction of special and expensive bunded fields and drainage channels. As these could not be prepared pots had to be used although it was realised that pots do not exactly simulate field conditions. There can be no doubt, however, that the drying of the pots can be adequately performed, and excessive drying was prevented by confining the dry periods to seven days.

The pots were situated in a plant cage to prevent damage by birds. The depth of soil in the pots was 10 in., and the normal depth of submergence (when the seedlings were tall enough) was 3-4 in. In both seasons four groups (hills) of three seedlings each were transplanted from field nurseries into each pot and the normal drainage and slight irrigation of the pots were followed until ten days after transplanting when the pots were submerged; i.e., from 3-4 in. of water were maintained in the pots; this, of course, did not cover the young seedlings. The pots dried periodically were kept submerged for fourteen days and dry for seven. A small opening was permanently kept in the bottom of all pots to simulate natural drainage. All pots were drained about a fortnight before harvesting.

For the *yala* experiment eighteen pots were used, nine of which were continually submerged. The two lots of pots were placed in two adjoining lines but there was no randomization of the pots. The mean yield of the periodically dried pots was 54·26 and of the submerged pots 59·36. The standard error of the mean difference was 2·85 (5·02%). The difference in yield is not statistically significant. A more precise experiment followed for *maha* in which twenty-four pots were used, in randomized groups of three giving eight replications. To the previous two treatments of periodic drying and continual submergence throughout the growth of the crop there was added a third treatment, that of periodic drying for the first three months followed by continual submergence thereafter. The results of the experiment will be found in table I and the analyses of variance in tables II and III.

TABLE I

Synopsis of the Irrigation Pot Experiment, Maha 1929-30

Treatment	Total yield of 8 pots in gm.		Mean yield per pot in gm.		Yield expressed as percentages of treatment B.	
	grain	straw	grain	straw	grain	straw
A. Periodic drying ...	504·5	631·0	63·06	78·87	76·27	74·24
B. Continual submergence ...	661·5	850·0	82·69	106·25	100·00	100·00
C. Combination of A. & B. ..	533·5	690·5	66·69	86·31	80·65	81·24

TABLE II

Analysis of variance, grain weights.

Variance due to	Deg. of F.	Sum of squares	Mean squares	S. D.	Log E.	SEmd.
Blocks ...	7	772·822				
Treatments ...	2	1748·999	874·4995	29·57	3·3868	
Exptl. Error ...	14	1292·834	92·3453	9·61	2·2628	4·93 (6·96%)
Total ...	23	3814·655		$Z =$	1·1240	5% point Z = ·6594

TABLE III

Analysis of variance, straw weights.

Variance due to	Deg. of F.	Sum of squares	Mean squares	S. D.	Log E.	SEmd.
Blocks ...	7	1404·096				
Treatments ..	2	3204·086	1602·043	40·03	8·6896	
Exptl. Error ...	14	1154·748	82·482	9·08	2·2061	4·54 (5·02%)
Total ...	23	5762·930		$Z =$	1·4835	5% point Z = ·6594

It will be seen that the continually submerged pots have beaten both the other treatments and the experiment with both grain and straw yields successfully passes the Z test. The close agreement between grain and straw differences is striking.

It may be definitely concluded that under normal conditions of drainage periodic drying has no advantage which is reflected in grain or straw yields and that on the other hand there is evidence to show continual submergence is beneficial.

(B) THE VIABILITY OF LONG-AGED PADDIES

One of the writers has already published* certain data about the germination of rice seeds in Ceylon, chiefly concerning the length of the resting period which ensues after harvesting before maximum germination is attained. The following account of the effect of age on viability is the natural continuation of the study there begun and shows the rapid fall in the germination percentage which takes place after seed has been left in storage for a year.

* Lord, L. The germination of rice seeds in Ceylon.—*Annals Roy. Bot. Gardens, Peradeniya,* XI, 2-123, 1929.

In this investigation the seed, nine different pedigree selections, was tested for viability at 7, 10, 13, 16, and 19 months after harvest. The seed was stored in a fumigated seed store at Peradeniya and the selections included both large and small grained rices. The age of the selections (that is the time from sowing to ripening) varied from 6-6½ months. In each test 400 seeds of each selection were taken and the test was carried out according to the technique described in the publication mentioned above.

The results of the tests will be seen graphically in Fig. I. From ten months after harvest the viability of the seed lessens and there is a heavy fall between the thirteenth and sixteenth month. By the nineteenth month none of the selections was viable. Normally the seed of long-aged paddies is sown 5½ to 6 months after harvest. Should unfavourable conditions prevent the crop being sown the seed will be useless for sowing the following year, that is eighteen months after harvest. Fortunately the complete loss of a crop in the regions when such long-aged paddies are grown is rare but where short-aged paddies (3-4 months) are grown crops are sometimes a complete failure or in bad seasons cultivation may not take place. In these cases the question of seed becomes urgent and is generally obtained from places where a crop was grown the previous year. The effect of age on the viability of short-aged paddies is under investigation.

(C) A NOTE ON THE EFFECT OF SOWING DATE ON THE AGE OF MAHA PADDY

L. LORD, AND J. S. T. DE SILVA,

THE correct sowing date for a variety of irrigated paddy is determined by (a) the date or period when the crop should ripen and (b) the age of the variety. There are very definite periods for most parts of Ceylon during which the crop must mature if satisfactory yields are to be obtained. Such periods may last for a month but are nevertheless comparatively restricted and are determined largely by weather conditions and to some extent by the incidence of paddy-fly attack. The weather at sowing time may influence the sowing date in that if sufficient water is not available at the proper time to enable the normal-aged variety to be grown a shorter-aged paddy must be sown later. Long-aged paddies (6-6½ months) seem to respond more markedly to change of sowing

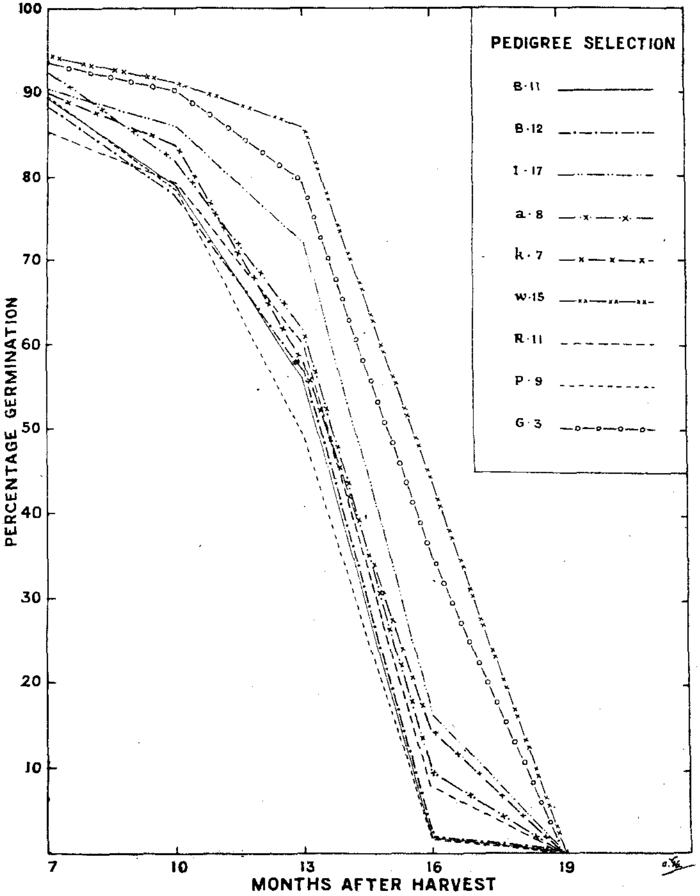


Fig. I.

The viability of long-aged paddy seed.

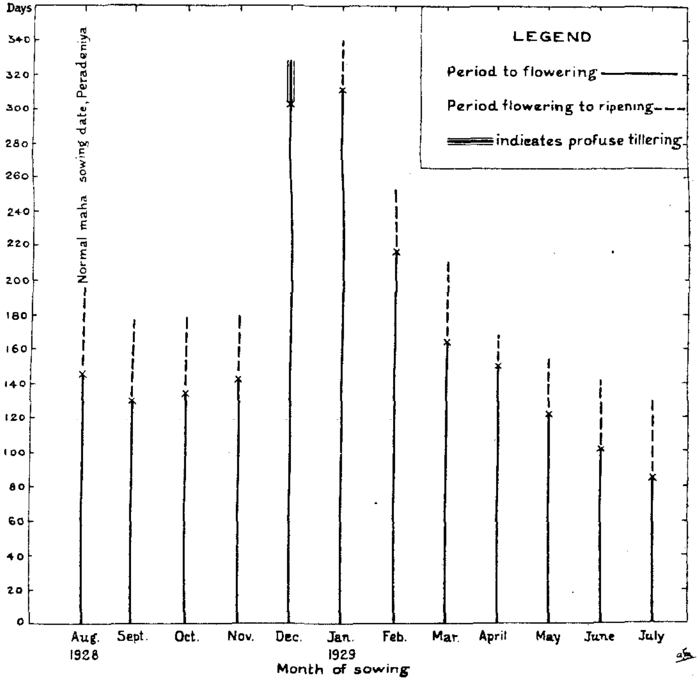


Fig. II.
The effect of sowing date on age of a maha paddy.

date than short-aged paddies and instances had been reported where long-aged paddies sown at the wrong time had never flowered.

The opportunity was taken at Peradeniya in 1928 and 1929 of sowing a *mawi* selection whose normal age was 6-6½ months, monthly throughout a complete year with the object of noting the changes in the growth period. These are shown graphically in Fig. II. The first sowing took place in August (the normal month for sowing at Peradeniya) and the last in the following July.

The normal age was 195 days and the September, October, and November sowing showed but little departure from this but from October onwards the panicles were not fully developed and yields in the field would have been unremunerative. The plants sown in December were caught by the north-east monsoon when normally they should have been flowering. No flowering took place at all and growth continued for 328 days. During the last 25 days profuse tillering took place. The January sown plants grew for 339 days and at maturity the few panicles formed were composed almost entirely of empty grains. From February onwards the age decreased until from May onwards it was very definitely sub-normal. In all these cases few panicles developed and all contained numerous empty grains. The effect of sowing at the wrong time will probably vary with different climates.

It will be seen that the meticulous care taken by the cultivator to sow the proper aged variety is sound agricultural practice.

CHEMICAL NOTES (10)

FURTHER ANALYSES OF LEGUMINOUS GREEN MANURES

S. KANDIAH AND D. G. PANDITTESEKERE
(DIVISION OF AGRICULTURAL CHEMISTRY)
DEPARTMENT OF AGRICULTURE, CEYLON

IN 1926, analyses of a number of green manure plants were made in the Chemical Division and the results published in *The Tropical Agriculturist* for October of that year. Since then several leguminous green manures have been introduced into Ceylon and it was thought desirable to analyse some of these, as well as a few of the more-important older species that had not been examined. With a view to obtain results which would be comparable, all samples were taken at the flowering stage only, and their leafy material and tender stems analysed. As previously pointed out it is obvious that the analytical figures obained cannot be regarded as representing the composition of all samples of the same species. It is, however, hoped that they would give a fair idea of the manurial values of these green manures.

The results of the analyses are calculated on the fresh material and on dry matter at 100°C. The sample of *Parochetus communis* was obtained from Lippakelle Estate, Talawakelle, the two samples of *Psoralea corylifolia* and *Rhynchosis nummularia* from the Northern Division, and the others from the Experiment Station, Peradeniya.

The results are set out in the table. An examination of it would show that the nitrogen as well as the ash contents in the fresh material of the various green manures vary a great deal. Of all the plants analysed *Derris robusta* appears to be the best as it contains the highest amounts of nitrogen, ash, lime, and potash. Its phosphoric acid content is also high. Lowest figures for all constituents in the fresh material are obtained in the case of *Parochetus communis* and this is evidently due to its low dry matter content which is only 14·3%, as compared with dry matter contents of 38% and 33·4% in *Derris robusta* and *Albizzia chinensis* respectively. The results on dry matter at 100°C show however that this plant has the highest amount of phosphoric acid and that its potash content too is comparatively

high. Thus it will be noted that a better idea of the relative value of the various green manures could be obtained by examining the results on material at 100°C.

The table shows that the figures for the various constituents obtained from these analyses are about the same as those obtained previously with the one exception of *Psoralea corylifolia* which has an ash content as high as 11·5% consisting chiefly of lime and potash. The percentages of nitrogen for the various species do not vary to any great extent. The nitrogen content is 3·47% obtained in the case of *Albizzia chinensis* as against a minimum of 2·48% in *Psoralea*. As already pointed out the highest amounts of lime and potash are found in *Psoralea*. The smallest percentage of lime is found in *Crotalaria brownei* and of potash in *Albizzia chinensis*. The latter has also a low percentage of lime. The phosphoric acid content is highest in *Parochetus* and again lowest in *Albizzia chinensis*. There does not appear to be any relation between the nature of the species analysed and their composition.

Analyses of Green Manures

No.	Variety	Nature of plant	On fresh material Per cent: Moisture	Organic matter	Ash	Nitrogen	Lime	Potash	Phos. acid	On dry matter at 100°C Per cent: Organic matter	Ash	Nitrogen	Lime	Potash	Phos. acid
1	Derris robusta	Tree	62·0	35·1	2·91	1·19	·74	·73	·19	92·3	7·68	3·14	1·98	1·93	·51
2	Albizzia procera	,,	73·5	24·1	2·43	0·69	·55	·68	·21	90·8	9·17	2·62	2·09	2·58	·81
3	Albizzia chinensis	,,	66·6	34·4	1·97	1·15	·46	·42	·15	94·1	5·92	3·47	1·37	1·24	·44
4	Crotalaria brownei	Bush	76·1	22·2	1·68	0·71	·29	·56	·16	92·9	7·06	2·93	1·24	2·36	·48
5	Psoralea corylifolia	,,	–	–	–	–	–	–	–	88·5	11·53	2·48	5·26	4·14	·55
6	Tephrosia tinctoria	,,	72·8	25·5	1·74	0·94	·47	·51	·14	93·6	6·41	3·45	1·75	1·88	·51
7	Desmodium heterocarpum	Bushy creeper	66·5	32·4	1·15	1·03	·46	·59	·16	94·2	5·81	3·07	1·38	1·76	·49
8	Parochetus communis	Creeper	85·3	13·4	1·34	0·42	·23	·37	·13	90·8	9·15	2·82	1·54	2·51	·87
9	Pycnospora hedysaroides	,,	66·7	30·8	2·48	1·07	·58	·67	·21	92·5	7·45	3·24	1·74	2·02	·63
10	Rhyncosis nummularia	,,	-	–	–	–	-	–	–	91·4	8·58	3·37	3·17	2·52	·69

SPRAYING AGAINST CANKER OF CITRUS

L. S. BERTUS,
ACTING MYCOLOGIST,
DEPARTMENT OF AGRICULTURE, CEYLON

SPRAYING experiments were begun on citrus trees (grapefruit) at the Experiment Station, Peradeniya, on 8 December, 1930. The trees were three to three-and-a-half years old and averaged about ten feet in height. Fifteen trees were selected for the experiment; of these, five were sprayed with a ½ per cent aqueous solution of concentrated lime-sulphur weekly, five with 1 per cent fortnightly while five served as controls. Before the experiment was started each tree was examined primarily to ascertain the severity of citrus canker on the leaves and branches.

Citrus Canker is one of the commonest diseases of citrus plants in Ceylon and is caused by the bacterium *Pseudomonas citri.* The disease is widespread in its distribution and is found in the United States of America (in Florida and some of the Southern States), in Japan, China, Java, India, Malaya, and Ceylon. In Ceylon it is more common at lower elevations, particularly in the wetter zones.

The first symptom of the disease is the appearance of yellow spots on the leaves. Later, small brown coloured, corky, eruptive growths are produced from these yellow spots. The character which distinguishes them from other eruptions of a similar nature is the yellowing of the leaf tissue round the eruption which gives the appearance of a sort of halo. The canker occurs on leaves, fruits, green twigs and young stems and in older stages may completely girdle twigs and young stems to cause the dying back of the parts above.

The presence of fungi and pests on these trees was also noted. Dr. J. C. Hutson, the Government Entomologist, identified the following pests: Fluted scale (*Icerya purchasi*), mussel-shell scale (*Lepidosaphes citricola*) and green bug (*Coccus viridis*) were found on the stems, while *Icerya seychellarum*, *Lepidosaphes gloveri*, *Lepidosaphes gloveri* var *pallida*, probably at least two species of *Chionaspis*, *Lecanium* sp., leaf miner (*Phyllocnistis citrella*) black fly (*Aleurocanthus* sp.) and aphids (*Toxoptera aurantii*) were present on the leaves.

Among the fungi recorded were *Septobasidium* sp. and sooty mould which develop on the secretions of scale insects, *Cephalosporium lecanii*, parasitic on green bug (*Coccus viridis*), *Microcera* sp. parasitic on *Lepidosaphes citriola* and *Chionaspis* sp.

The primary object of the experiment was to ascertain the efficacy of the spray fluid against the spread of the bacterium which caused citrus canker on leaves, branches, and fruits; it also afforded an indication of the effect of the spray on fungi and insects commonly present on citrus.

Fungi like sooty mould and *Septobasidium* sp. which live on the secretions of the scale insects are not very harmful when they are present in small quantity, but when they occur in abundance they may seriously retard growth and render the tree less resistant to drought. The dense, black structure which the sooty mould fungus forms on the leaves reduces the amount of light reaching the chlorophyll and consequently diminishes the activity of the latter in manufacturing food.

Pests like fluted scale, green bug, and aphids reduce the vitality of the tree by sucking its plant juice. All these factors working together may have a detrimental effect on the health of the trees and their subsequent production of fruit.

No attempt was made to cut off affected twigs and leaves as it is realized that this procedure would be impracticable especially in the case of large trees where in severe attacks a large percentage of the leaves are affected.

As stated above five trees were sprayed weekly with a ½ per cent aqueous solution of concentrated lime-sulphur, and five trees fortnightly with a 1 per cent solution. After the former group had received ten applications and the latter five, the trees were individually examined. It was observed that the spray did not arrest the spread of the canker to the young shoots to a marked degree, that some of the scale insects were not killed in the trees which were treated with the ½ per cent solution and that the leaf mining caterpillar was still active carrying the bacterium of the canker to young foliage.

On 16 February, 1931 a change was effected in the strength of the spray fluid. The trees that received a ½ per cent solution of the lime-sulphur were treated with a 1 per cent solution and those that received the 1 per cent were sprayed with a 2 per cent solution. After the former group had received eight applications and the latter four of the increased strengths the trees were again individually examined. The effect of the increased strength of the spray fluid was noticeable. Pests such as green bug and scales were completely wiped out together with the fungi such as sooty mould which lived on their secretions; the *Septobasidium* which enveloped the larger branches were seen to have cracked and dropped off; the spread of the canker to the young foliage was arrested to a considerable extent; the leaf mining caterpillar was present but the damage it did was

negligible. From observations made it appeared that the leaf miner infected the leaves in the interval between the application of the spray fluid. The spray did not appear to be completely effective against ants and aphids though their numbers were reduced considerably. No difference was noticeable in the trees sprayed weekly with the 1 per cent solution compared with the trees sprayed fortnightly with the 2 per cent solution.

From the above experiments and observations made in the field it is recommended that (1) trees should he sprayed weekly with a 1 per cent aqueous solution of concentrated lime-sulphur or fortnightly with a 2 per cent solution, (2) affected twigs and leaves should be cut off and burnt wherever possible. The Entomologist suggests that the application of a spray of tobacco wash between the application of lime-sulphur will be effective against aphids and leaf miner.

Canker infection takes place most readily on young leaves. If new foliage growth can be stimulated during the drier periods of the year in which canker infection is not so common, some infection may be avoided. Young trees should therefore be watered during dry weather to stimulate growth and if manuring is undertaken it should be done so that the maximum effect is felt during dry weather.

Wherever possible infected twigs and foliage should be pruned out to remove sources of infection. Spraying against citrus canker is a preventive and not a curative measure. Once the bacterium is inside the tissues of the host plant spraying will not eradicate it but will, to a great extent, prevent it from spreading to neighbouring leaves and branches.

If citrus is planted 15 feet by 15 feet, 195 trees will cover an acre. In the experiments described above, 2 gallons of solution were used for five trees. This quantity was considered the minimum amount of spray fluid required for the trees of the size experimented upon. Based on these calculations roughly 13 pints of concentrated lime-sulphur solution will be required for spraying an acre of citrus with a 2 per cent solution.

If the citrus plants are young, spraying can be carried out with small hand sprayers; if done on a larger scale or if hig trees are to be sprayed, the use of a knapsack sprayer will be most convenient.

If the routine spraying recommended above to control citrus canker is adopted, the spray will help to prevent infection by pink disease (*Corticium salmonicolor*) and mildew (*Oidium tingitaninum*) which are responsible for dieback in citrus and when once established on a plantation are troublesome to eradicate.

TEA MANURING UNDER SLUMP CONDITIONS

W. R. THOMSON, B.Sc. (AGRIC.)

THE problem facing those responsible for many tea estates at present is that of finding methods of reducing the cost of production of their tea. The drop in prices has in many cases reduced the margin of profit to a vanishing point and all expenditure must be scrutinised with the utmost care.

An obvious economy is the reduction or elimination of the eight or ten cents per lb. spent on manuring. Reports of the bad effects following on the cessation of manuring in the 1921 slump are however such that many regard the discontinuance of manuring as a policy of extremely doubtful value when a long view is taken.

While this is undoubtedly true, the problem of finding immediate economies is so pressing that some discussion of the problem as it affects manuring expenditure may be welcome.

The simplest method of economy is to apply the mixtures already in use at a reduced rate per acre but it can possibly be improved upon.

It must be remembered that the fate of the various plant foods which have been added to the soil in the past has varied considerably. Practically the whole of the Phosphoric Acid which has not been actually removed in the tea leaf will be found in the soil, the frames of the bushes, or in the green manure crop.

The bulk of the Potash will be found in the same way, though a larger amount will probably have been lost by drainage.

On the other hand the accumulation of reserve stores of Nitrogen is difficult and the effect of past applications can be very largely discounted. The process of building reserve stocks of Nitrogen even when slow acting organic manures are used and green crops are grown is very slow. The estate which has by these means built up the fertility of its soil to a really high degree is extremely fortunate at the present time. It must be remembered however that nothing is easier to lose than this fertility under Ceylon conditions where all the factors which make for Nitrogen losses are at their maximum.

The reduction in manuring expenditure should then, from theoretical considerations, fall rather more heavily on the Phosphates and Potash of the manure mixture than on the Nitrogen. The actual cuts which can be made in this expenditure will depend on the past manuring history of the estate as manuring

programmes vary widely in the proportions of plant food they supply. Reduction of the amount of Nitrogen used in mixtures is a more difficult problem but the fact that this ingredient is very much the most expensive used makes it essential to reduce the money spent on this item if at all possible.

One method of reducing the cost of this is to substitute cheap inorganic Nitrogen for more expensive organic forms, but it must be remembered that inorganic Nitrogen while it gives a rise in crop over a short period tends to lower the quality of the tea produced. Any increase in the amount of this form of Nitrogen at the present time is therefore so much against the general interests of the industry that it cannot be entertained even though the immediate results may be superficially attractive to individual estates. From both the estate and the general point of view the ideal must be to produce a crop of the best possible quality at a lower cost per lb. and these objectives must be attained without any damage to the high state of general agricultural health of the properties.

The only means of attaining this end is the use of good quality organic material as the source of the greater part of the Nitrogen.

The reduction that must be made in the total Nitrogen to be applied should then take effect to a greater degree on the inorganic Nitrogen while the organic Nitrogen is cut to a much smaller extent if at all.

There is no ground for selecting any particular form of Phosphoric Acid or Potash to be reduced in preference to any other and cuts can be made on the total amount without reference to the forms used. The amount of the cut should of course depend on the amounts previously used for the reasons set out above.

Such a programme should obviate the bad effects of a reduction in the amount spent on manure. The loss of crop is reduced to a minimum while quality is retained or even improved. No drastic alteration is made in the food supply to the bush and the evenness of action obtained from a largely organic mixture will maintain the general fertility and health of the estate as a whole.

The part played by inorganic Nitrogen in the production of the present surplus of tea is considerable and the quantity of tea attributable to this source in a normal year is estimated at 56,000,000 lb. While it is not suggested that the whole of this inorganic Nitrogen should be dispensed with a considerable reduction is possible and this combined with a smaller reduction in organic Nitrogen would restrict production to a considerable extent with a correspondingly good effect on the market.

CONTRIBUTIONS FROM THE RUBBER RESEARCH SCHEME, CEYLON

THE CAUSE OF VARIABILITY IN THE PLASTICITY OF PLANTATION RUBBER AFTER STORAGE

G. MARTIN, B.Sc., A.I.C., F.I.R.I.
AND
L. E. ELLIOTT, F.I.C., F.I.R.I.
(OF THE SCIENTIFIC STAFF IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME)

THERE are two reasons why a study of the plasticity of rubber is of importance to the planter, viz: (1) the variable plasticity of plantation rubber leads to many difficulties in manufacturing operations; and (2) first-grade plantation rubber is so hard that it is frequently mixed with inferior grades and other materials to enable it to pass more easily through the different processes.

The results of the investigations recorded in this report suggest a definite reason for the hardness and variability of first-grade rubber.

Tests carried out by De Vries in Java showed (1) the freshly prepared plantation rubber is uniform in plasticity but that many samples gradually become hard or soft on keeping and so develop differences; and (2) that rubber containing more serum substances than usual becomes hard and that containing less than usual becomes soft (Trans. I. R. I., **3**, 1927-28, p. 284). On the other hand tests carried out by the Scheme on a large number of samples of over three years show that in most cases rubber becomes harder on keeping for six months at 15°C. The hardening of the rubber at European temperatures has been confirmed by Griffiths of the Dunlop Rubber Co., Ltd., who stated that large-scale experiments on rubber from different estates showed that in all cases, after storage for three years, it was necessary to increase the time of milling by about 30 per cent in order to obtain the required plasticity (Trans. I. R. I., **3**, 1927-28, p. 300).

As raw rubber is subjected to a wide range of temperatures and humidity conditions before use by the manufacturer a detailed investigation is being carried out at the Imperial Institute on the effect of different conditions of storage.

The results of preliminary tests (Second *Quarterly Circular* of the Rubber Research Scheme, Ceylon, 1930) showed that (1) rubber becomes slightly harder at 15°C than at 0°C; and (2) rubber hardens more quickly in a dry than in a damp atmosphere.

Further experiments have now been made with crepe and sheet stored for six months at 0°C, 15°C, 30°C, and 45°C. As it was desirable to ascertain whether the changes in plasticity were due to changes in the rubber independent of external factors such as oxygen, some of the samples were kept in sealed glass tubes containing dry nitrogen and others in tubes containing dry oxygen. If oxygen is responsible for changes in the plasticity of rubber on storage, it might be anticipated that the changes would be accelerated by the removal of anti-oxidants from the rubber. Accordingly a portion of the sheet was treated with dilute ammonia solution for three weeks to remove anti-oxidants; another portion was treated with water for comparison; and a third with tannic acid solution, the tannic acid being regarded as a possible anti-oxidant. The results of the usual hardness tests at 100°C are shown in the following table and diagrammatically in Fig. 1.

Sample	* D_{30} (mm./100) before storage	* D_{30} (mm./100) after storage for six months in							
		Dry nitrogen at				Dry oxygen at			
		0°C	15°C	30°C	45°C	0°C	15°C	30°C	45°C
Crepe (No. 1452)	170	178	205	213	222	156	173	185	164
Smoked sheet (No. 1455)	191	186	203	208	215	173	183	182	182
Smoked sheet extracted with cold water	189	—	209	—	—	175	188	—	142
Smoked sheet extracted with ammonia	189	—	213	—	—	166	186	—	111
Smoked sheet soaked in tannic acid	189	—	217	—	—	170	191	—	162

* D_{30} = Thickness (in hundredths of a millimetre) of sphere 0·4 grams in weight after pressing under a load of 5 kgs. at 100°C for 30 minutes.

The results show that the changes in hardness which occur when rubber is stored in dry oxygen are different from those which occur on storage under the same conditions in nitrogen. In nitrogen the rubber becomes hard and the hardness increases with the temperature. In oxygen the rubber is always softer than in nitrogen at the same temperature and the difference increases with the temperature.

These results suggest that two fundamental factors are responsible for the changes which occur in the plasticity of rubber on storage: (1) a spontaneous hardening which occurs in nitrogen and therefore probably in any inert atmosphere; and (2) a softening induced by oxygen. These changes occur simultaneously when oxygen is present, but an increase in temperature accelerates the rate of softening more than the rate of hardening. At low temperatures hardening exceeds softening and at high temperatures softening exceeds hardening and, as will be seen from the diagram, the critical temperature is about 30°C but depends upon accessory substances in the rubber.

The ammonia-extracted rubber became extremely soft in oxygen at 45°C, although it hardened at 15°C, whilst the same rubber not treated with ammonia had a tendency to harden even at 45°C. Previous experiments with ammonia-extracted rubber have indicated that it possesses poor ageing properties when vulcanised, and it is assumed that this is due to the removal of anti-oxidants. (Trans. I. R. I., 1926-7, **2**, p. 368). The removal of these constituents therefore appears to affect not only the ageing properties of the vulcanised material but also those of the raw material.

The water-extracted rubber also softened in oxygen at 45°C but not as much as the ammonia-extracted rubber; this also agrees with the results of the ageing tests on the vulcanised material referred to above. Tannic acid does not appear to have a marked anti-oxidant effect.

These results explain the differences previously observed between the effect of storage in the tropics and in Europe. At European temperatures spontaneous hardening nearly always exceeds softening due to oxygen, even when the amount of anti-oxidants present is much less than usual. At tropical temperatures rubber becomes hard or soft according to the amount of serum substances present. These contain natural anti-oxidants, with the result that even at tropical temperatures rubber containing more serum than usual becomes hard.

Although this work is only in its initial stage the results indicate methods by which it may be possible to control the plasticity of rubber on estates.

HARDNESS (D30) of raw rubber after exposure for six months in dry OXYGEN or NITROGEN at different temperatures.

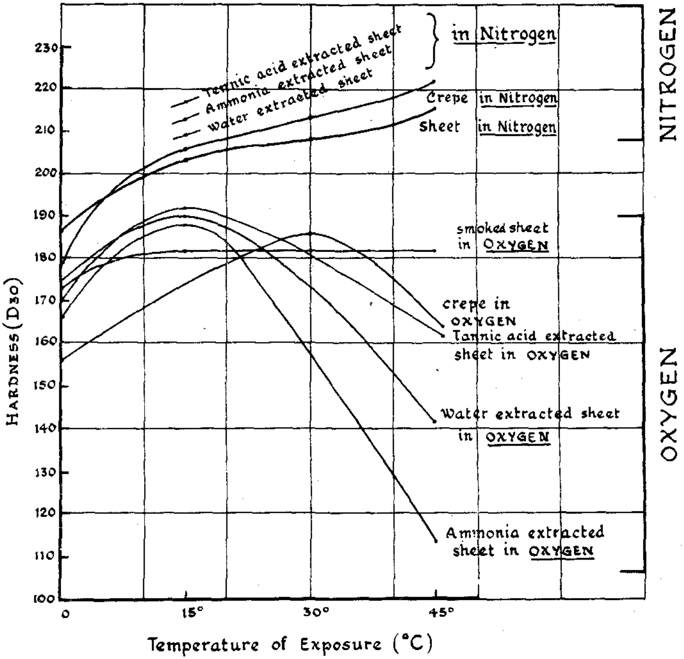


Fig. I.

THE EFFECT OF MATURATION ON THE PLASTICITY OF SMOKED SHEET

G. MARTIN, B.SC., A.I.C., F.I.R.I.
AND
L. E. ELLIOTT, F.I.C., F.I.R.I.
(OF THE SCIENTIFIC STAFF IN LONDON OF THE CEYLON RUBBER RESEARCH SCHEME)

IT is the practice in Java when preparing smoked sheet rubber to remove the coagulum from the serum on the same day as the acid is added, but in Malaya and Ceylon it is more useful to remove the coagulum on the day following. During the period the coagulum remains in the serum, changes occur in the non-rubber accessory substances which affect the rate of vulcanisation of the rubber. It is to be expected therefore that these changes occur to a greater extent in Ceylon and Malaya than in Java, and that the different practices lead to some variability in the properties of rubber.

Although the effect of keeping the coagulum in the serum has been studied thoroughly as regards rate of vulcanisation little is known as to whether the changes which occur affect the plasticity of rubber. This also is an important property affecting the utilisation of rubber.

Two sets of experiments were described in Bulletin 49, p. 2, showing that crepe from coagulum kept in the serum for two days was harder than crepe from coagulum removed after a few hours.

Two further sets of experiments have now been carried out in which the coagulum after keeping for different periods in the serum was rolled to sheet and smoked. The results obtainted are not in agreement with those given by crepe, the period the coagulum remained in the serum apparently having no effect on the plasticity of sheet. Mr. O'Brien (who prepared the samples) has suggested that the difference in the results given by crepe and sheet is due to the addition of sodium bisulphite to the latex when preparing crepe. This is a probable explanation because it has already been shown that sodium bisulphite has a hardening effect on rubber, and it is possible that the longer the coagulum remains in the serum the greater is the effect of the bisulphite.

More information concerning the different results given by crepe and sheet could be obtained by determining the plasticity of crepe prepared from latex containing no bisulphite and matured for different periods, and it is hoped to carry out this experiment when opportunity occurs.

The two sets of sheet samples were prepared at an interval of 18 months. A description of the first set and the results obtained are given in the Rubber Research Scheme *Quarterly Circular*, Vol. 6, Part 2, 1929, p. 1. The samples in each set were prepared from latex divided into two portions, one being coagulated with acetic acid and the other with a mixture of acetic acid and paranitrophenol. The latter is a disinfectant used chiefly for the prevention of mould. It was employed in these experiments to determine whether it retarded changes in the accessory substances during the period the coagulum was kept in the serum. In the second set a portion of the sheet from the coagulum which had been allowed to remain in the serum for the longest period was rolled up wet and kept in this condition for five days before drying in smoke. At the end of this period the sheets without paranitrophenol had a putrid odour but the others were still fresh.

Plasticity Tests.—The results of plasticity tests are shown in table I. They include a hardness test soon after the arrival of the samples in London and after keeping for six months, and in addition a mastication test on the stored samples.

The results show that keeping the coagulum in the serum had no definite effect on the hardness of the sheet samples on arrival in London or after storage for six months under different conditions (for detailed particulars of conditions of storage of the first set and the results obtained see *Quarterly Circular*, Vol. 6, 1929, Part 2, p. 2 and, Vol. 7, 1930, Part 2, p. 23). It is of interest however that the sample rolled up wet and free from paranitrophenol in the second set was harder than the others on arrival and required more mastication than the others after keeping at 60°F for six months. It is possible therefore that maturing the coagulum may cause a small decrease in plasticity, but this is not obvious from tests in which the coagulum is allowed to remain in the serum and then rolled and dried, because the biological changes may be accompanied by an alteration in the distribution of the non-rubber substances between the coagulum and the serum.

Paranitrophenol had no definite effect on the hardness of the samples except when these were stored in a damp atmosphere when the samples without paranitrophenol became mouldy and hard.

Vulcanisation Tests.—Most of the samples were submitted to tests to determine the extent to which the changes occurring during the maturing of the coagulum affected the rate of vulcanisation, and the influence of paranitrophenol on these changes. The results obtained are shown in table II. In the first set of experiments only small changes occurred in the rate of vulcanisation of the samples in consequence of keeping the coagulum in the serum and these changes were unaffected by paranitrophenol. In the second set of experiments the alterations were more marked. Keeping the coagulum in the serum for 44 hours as compared with 4 hours reduced the time of vulcanisation by 15 per cent in the absence of paranitrophenol and by 8 per cent in the presence of paranitrophenol. When the coagulum kept in the serum for 44 hours was rolled up wet, the time of vulcanisation was reduced by a further 10 per cent in the absence of paranitrophenol and by 5 per cent in its presence.

In the first set of experiments paranitrophenol had little effect on the changes which occurred when coagulum was allowed to mature but in the second set it definitely retarded these changes. As the changes which occur during maturing may be partly due to accidental infection it is not surprising that different experiments do not always agree. It is evident that paranitrophenol may reduce variability due to differences arising during maturation of the coagulum but insufficient evidence has yet been obtained as to its general effect in this direction.

Set 1

Table I

Sample No.	Coagulant	Interval between addition of coagulant and rolling	On arrival in London	After storage for six months at 60°F	
			D_{80}	D_{80}	Mastication
		hrs.	mms./100	mms./100	No.
1,385	Acetic acid	4½	154	161	94
6	,, ,,	17¾	158	158	95
7	,, ,,	35½	156	165	95
8	,, ,,	40¼	156	161	120
9	,, ,,	55½	159	167	109
90	Acetic acid and	4½	151	156	104
1	paranitrophenol	17¾	158	151	109
2	,, ,,	35½	155	158	108
3	,, ,,	40¼	156	163	105
4	,, ,,	55½	155	167	107

Set 2

Sample No.	Coagulant	Interval between addition of coagulant and rolling	On arrival in London	After storage for six months at			
				32°F		60°F	
			D_{80} mms./100	D_{80} mms./100	Mastication No.	D_{80} mms./100	Mastication No.
1,500	Acetic acid	4	159	153	92	157	98
1,501	,, ,,	18	159	150	94	159	107
1,502	,, ,,	23	164	154	93	161	107
1,503	,, ,,	28	159	158	101	157	96
1,504	,, ,,	44	160	161	97	153	98
1,505	Acetic acid and	4	152	152	93	158	92
1,506	paranitrophenol	18	158	155	94	160	101
1,507	,, ,,	23	156	151	93	159	96
1,508	,, ,,	28	161	156	101	168	98
1,509	,, ,,	44	159	149	92	165	100
1,510	Acetic acid (sheeted coagulum rolled up wet)	44	169	156	96	170	110
1,511	Acetic acid and paranitrophenol (sheeted coagulum rolled up wet)	44	164	152	95	159	102
1,512	Estate sample	—	154	157	94	159	96

Table II

Set 1 Mixing 90 rubber, 10 sulphur

Sample No.	Coagulant	Interval between addition of coagulant and rolling	Time of vulcanisation	Tensile Strength	Elongation at load of 1·04 kgs./sq. mm.	Calculated time of vulcanisation at 148°C (E 1·04 = 775)
			mins.	lb./sq. in.	per cent	
1,385	Acetic acid	4½	120	1,580	853	120
6	" "	17¾	"	1,670	848	118
7	" "	35½	"	1,830	832	114
8	" "	40¼	"	1,840	840	116
9	" "	55½	"	1,850	820	111
90	Acetic acid and	4½	"	1,460	860	121
1	paranitrophenol	17¾	"	1,950	840	116
2	" "	35½	"	1,560	847	118
3	" "	40¼	"	1,830	824	112
4	" "	55½	"	1,950	824	112

Set 2 Mixing 100 rubber, 10 sulphur

Sample No.	Coagulant	Interval between addition of coagulant and rolling	Time of vulcanisation	Tensile Strength	Elongation at load of 1·00 kgs./sq. mm.	Calculated time of vulcanisation at 148°C (E1·00 = 800)
			mins.	lb./sq. in.	per cent	
1,500	Acetic acid	4	120	1,970	846	134
			140	1,990	777	
1,504	" "	14	100	1,710	852	114
			120	2,050	780	
1,505	Acetic acid and paranitrophenol	4	120	1,960	840	133
			140	2,120	776	
1,509	" "	44	120	2,100	807	122
1,510	Acetic acid (sheeted coagulum rolled up wet)		100	2,230	807	102
1,510	Acetic acid and paranitrophenol (sheeted coagulum rolled up wet)	44	120	2,320	784	116

RESEARCH WORK ON RUBBER CULTIVATION IN 1929 (Continued)*

Yield.—An extensive enquiry was made by Tengwall on the production of 275 estates in Java and South Sumatra with a total of 64,482 hectares. He figured out the average yield of fields of the same age and got the following figures:

Table X

Planting Year	Age of the fields years	Kilogram rubber per hectare
1923	4-5	71
1922	5-6	223
1921	6-7	271
1920	7-8	291
1919	8-9	321
1918	9-10	352
1917	10-11	372
1916	11-12	417
1915	12-13	392
1914	13-14	393
1913	14-15	436
1912	15-16	467
1911	16-17	441
1910	17-18	435
1909	18-19	434
1908	19-20	398
1907	20-21	432
1906	21-22	375
1905	22-23	394
1900-1904	23-24	449

In representing these figures in a curve, it becomes apparent that the increase-decrease in following years shows several irregularities. It must be taken into consideration, that the average figures have been obtained from rather heterogeneous material from fields of very different productivity. The figures show, that the decrease in production generally sets in not before the 15th-16th year. When we realise, that in the old fields the cultural conditions have often been unfavourable (much soil-wash, no green-manuring, etc.), the tapping system too drastic, the bark renewal poor, it may be expected that the increase in yield with the younger fields will last longer than in the old fields, so that the decrease in yield will set in later than in the fields under consideration.

Selection.—A general review of Hevea selection in Java was given by De Vries, Schweizer and Ostendorf. From this exposition it is apparent that the planting of selected trees, either seedling or budded trees is in Java not yet so general as in Sumatra, but the interest in selection is at present very great and a great number of clones of superior mother trees are grown on different estates: 85 clones at 6 estates are under observation of the Rubber Experiment Station. Three clones of the Estate "Bodjong Datar" (from mother trees of the Estate "Pasir Waringin") have been well tested and could be recommended to the estates; the average production was at the age of 9 years: 6·35 kg., 7·65 kg., and 6·90 kg. rubber (dry) per tree per year.

* From *International Review of Agriculture*, Part 1, Year XXI, No. 9, September 1930. Part I of this paper was reproduced in *The Tropical Agriculturist*, Vol. LXXVI, No. 2, 1931.

In 1926 a beginning has been made with the more systematic testing of the different clones. To this purpose different clones have been planted together in one field, each clone in a number of plots (say 3 or 4) of ½ to ½ ha. each; or the different clones have been planted in rows, each row of no more than 20 trees and alternately a row of the clone to be tested with a row of the so-called "standard clone", i.e., a clone which has already been tested for several years and the production of which is used as a standard. Of each clone two to six rows have been planted. In these experiments the trees have been planted at a rather large distance, viz., at the rate of 240 to 330 trees per ha.

In Ceylon selection as a plantation practice is still rather backward, L. Lord in a lecture delivered in Colombo, gave a general review of the situation in Ceylon and nrged the planters to give the policy of rejuvenation a thorough and wide trial, using for all new plantings the best available material and prosecuting energetically research on the production of superior material. He advised strongly to test a great number of estate trees as mother trees and to test foreign clones. If these measures would be taken the lecturer thinks that there would be no reason for pessimistic views regarding the future of the rubber industry in Ceylon.

In selecting the high-yielding mother trees we are still obliged to follow the ordinary way of measuring the yield of the trees during at least one year. We have not a reliable method of estimating the yield by means of correlating characters.

As De Vries showed, it is still uncertain what may be expected from Ashplant's method of measuring the diameter of the latex tube.

As a general tapping system for the trees which must be tested for selection, the alternate-day tapping over 1/3 has been adopted in Java and in comparative experiments three clones (Ct 88, AV 36, and AV 50) are included as "control" or "standard clones." A reliable impression of the productivity of a clone can only be obtained by experimental tapping continued during one year, or, better still, during several years.

A short review is given by De Vries of the Hevea plants imported in Java from Brazil. It appears that practically all the Hevea trees in Java are descendants from the trees grown from seed which Wickham collected in Brazil in 1875.

On different estates a great number of mother trees have been selected and the yield has been recorded during several years. The Besoeki Experiment Station (Djember) and the Rubber Experiment Station (Buitenzorg) kept a number of these trees in regular observation. This collection contains trees which give an average of more than 150 gm. rubber (dry) per tapping, being tapped on alternate days over 1/3; a few trees give more than 300 gm. per tapping.

The simplest method of selecting consists in planting seedlings grown from "illigitime" seeds (seeds obtained by uncontrolled pollination) from selected mother trees. The fields planted with these seeds have shown that in this simple way a remarkable improvement of the production may be obtained. A field of the Estate "Passir Waringin" of 21½ ha. planted in 1916 with such seeds, gave the following yields:

7th	8th	9th	10th	11th	12th	13th	year
390	600	666	820	717	703	745	kg. dry rubber per ha.

A field of the Estate Petaroeman, planted in 1916 and 1917 with "illigitime" seeds from selected mother trees of the Estate Kiara-Pajoeng gave the following yields:

	6th	7th	8th	9th	10th	11th	year
Estate Petaroeman	340	497	573	700	745	775	kg. dry rubber per year per ha
Average production	200	280	360	420	450	470	do do

Artificial cross-pollinations between trees of high yield and specially between trees of the best clones have been effected in Java in the last few years on a large scale. Records of yield of the seedlings are not yet available.

A few estates have made isolated fields planted with two or more high yielding clones. Of the seeds produced in these fields it is certain that father tree as well as mother tree is a high-yielder. From the fields planted with seeds from these fields records are not available either.

Other Hevea species than *H. brasiliensis* have been imported in Java viz. *Hevea collina*, *H. spruceana*, and *H. guyanensis*, but they have not shown any character which seems especially desirable. They have not been used for hybridisation experiments.

The practice of budding has been the subject of various investigations. In Java De Vries and Vrolyk made an enquiry about the results of the budding practice on the estates; seventy-five estates gave the information asked for.

The average percentage of success is still low in Java: only 60%. This may be partly the consequence of lack of training of the labourers to whom the budding work is entrusted, but there are still other causes. One of these is that budding is sometimes effected under unfavourable circumstances, and the enquiry proved clearly that budding is not equally successful in the different months. De Vries and Vrolyk figured out for each estate the success of budding obtained in each month in comparison with the success obtained in the most successful month. The figures thus obtained are combined into the following list :

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
Percentage of success (i.e., percentage of the success-percentage, obtained in the best month)	69	72	76	83	76	80	76

These figures show that it is advisable to wait some time after the beginning of the rainy season before starting budding; in October the stock and scion are generally not yet in the best condition for budding.

Vrolyk and Ramaer investigated this question more in detail. They realised that the differences in success obtained by budding in different months is the consequence of the differences in stage of growth of the scion and of the stock. The object of their investigation was to find in what stage of growth scion and stock are most suitable for the budding operation. They proved that the success in budding is greatest when the stock and the scion have just started to make a new sprout and the first leaves of this sprout are still very small and brown in colour. A little later when the new leaves have adopted a green colour and are still weak and hanging the percentage of success is already a little lower but still satisfactory. The older the new sprout of the stock the less suitable it is for budding, and the same is the case with the scion.

The question what seedlings are to be preferred for stock is still a puzzling one; one thing is apparent, viz., that quick-growing seedlings have the advantage of being earlier fit to serve as stock than slow-growing ones. This fact induced Schweizer to investigate whether seedlings of different mother trees show marked difference in quickness of growth. His investigations showed that this is indeed the case, so that "growth-velocity" must be regarded as a hereditary character; quick-growing mother trees seem to give as a rule quick-growing offspring. In using such seedlings some estates were able to perform the budding operation three months earlier: the seeds were collected in March and budding could be done in the beginning of the rainy season (November-December). Schweizer investigated also whether it is advantageous to use large seeds for

growing stock but, though the plants raised from large seeds are in the beginning stronger than plants from average or small seed, the difference is no longer to be seen after a few months. Thus there is no advantage in the use of large seeds for raising seedlings for stock.

As De Vries and Vrolyk mention, a thing which is in Java the cause of much disappointment is the dying off of buds after they have grown together with the stock. This occurs much more in the dry season than in the wet season (22·7% against 4·6%).

Budding in the nursery is in Java more generally applied than budding in the field (87% against 13%) and it has a greater success-percentage, as is to be seen from the following figures :

Table XI—Success-percentage of budding.

	In the nursery	In the field
	%	%
Besoeki (East Java) ...	53	36
Malang (East Java)	77	55
West Java ...	52	49

In this connection the investigations of Man in Malaya may be mentioned.

Budding in the field is carried on in Malaya to a great extent (figures are not given), though failures are more numerous than in budding in the nursery. Under nursery conditions it is possible to choose stocks in the best stage of growth for the operation, while under field conditions choice is much restricted. But the advantage is, that in budding in the field the budded plants are not checked in their growth by being transplanted.

Man considers the vigour of growth of stock and scion at the time of the budding operation as the most important factor influencing success, and the unfavourable results obtained with budding under drought conditions, especially on sandy soils, must be attributed to the less vigorous growth.

In order to prevent the dying off of the bud aftèr opening the author advises to protect the bud. This may be done by trying a shade of leaves around the freshly budded stock immediately above the waxed binding. By this measure the newly-formed wound healing cells (callus) are prevented from dying. Another thing, which Man considers as important, is to take care in budding that patch and pannel fit well so that no wide gaps separate the edge of the patch from the cut edges of the bark of the stock. The following figures are given, which illustrate the influence of drought and of shading the bud :

Table XII

Period of budding	Percentage of success immediately after opening the bud	Percentage final success	Loss after opening as a percentage of initial success
Clone 1 Showery (April-May)	**98**	**84**	**14**
Drought (May-June)	**99**	**70**	**29**
Clone 2 Showery (April-May)	**88**	**85**	**3**
Drought (May-June)	**80**	**35**	**56**

Table XIII

Shading		Percentage of success immediately after opening the bud	*Percentage* final success
Clone 1	Light or none	91	70
	Heavy	99	87
Clone 2	Light or none	57	48
	Heavy	88	84

In Java the most generally applied budding method is the "modified Forkert method"; in East Java, however, some estates apply the "patch budding". The success-percentages obtained by the two methods were as follows :

Table XIV

Estate	Modified Forkert method	Patch budding
Besoeki (East Java)	55 %	49 %
Malang ,, ,,	76	66

The Forkert method seems thus slightly more successful.

Budding does not succeed equally easily with different clones. In Java for instance clone BD 5 gives the highest success-percentage. Clone AV 152 the lowest. The same experience of different success with budwood of different clones has been gathered in Malacca.

About the influence of the stock on the scion we are still entirely ignorant. Dias surprised us with the statement, that "to a certain extent" the growth of the scion is not at all influenced by the stock. He claims that the bud in developing envelope all round the stock, and that the stock "attains a dormant state" and "increases neither in girth, breadth, length or in any other manner."

This statement, which will certainly not be credited by many botanists and planters, was criticised by Taylor. This author lays stress on the fact, that there is a considerable amount of information available on the influence of stock on scion with other plants than Hevea. This information goes to show that while each of the two retains its general characteristics there is a decided interaction between the two. Taylor considers that research work on bud-grafting in Hevea should keep in mind the possibility of such influence. He says that there seems to be an indication that plants budded on their own stocks grow better. In Java the Rubber Experiment Station takes the same stand and an investigation has been started on the influence of the stock on the scion.

The use of cutting off the "snag" flush with the top of the bud was emphasised by Weir. If this is done in the proper way, the cut sloping downward away from the bud, and at the proper time, say when the bud has grown 4-8 ft. and shows considerable brown bark, the amount of decayed wood remaining on the stock may be very little or may be entirely absent. In many cases however, especially if the snag is cut square across or cut too high, the decay may advance so far below the point where the cut is

usually made that an appreciable amount of decayed wood may be sealed in by callus tissues. The decayed wood next to the bud side of the stock may, before the callus is complete, cause the young tree to be overthrown by the wind. Also the shoot may be broken off by the wind if the cut exposes the decay so close to the bud that the callus does not form rapidly at that point.

The packing of budwood is a practical question of some interest, as the budwood must often be obtained from places more or less remote. Billington recorded the success in budding with budwood packed in different ways. The budwood was transported from Siantar (Sumatra) to Kuala Lumpur. The material was sent from Siantar to Belawan by train, from Belawan to Penang by boat and from Penang to Kuala Lumpur by train, a journey which took three days. Three different methods were used: (1) coconut fibre was put between the layers of budwood sticks, (2) each group of sticks was wrapped in a banana-sheath securely tied with string, the bundles so formed being buried in dry saw-dust, (3) each stick was wrapped in dry sacking and tied with string, and each group of five sticks was rolled in a further piece of dry sacking, and tied and buried in charcoal. All three methods of packing have proved suitable. To differentiate definitely between tbe methods a longer journey is evidently necessary. In the opinion of Billington it seems, however, that the charcoal and sacking method appears to keep the bark in more pliable and tractable condition.

One common objection advanced against budding is that budded trees may not renew the bark so satisfactorily as seedlings and that they will have to be allowed a longer period for bark renewal.

Billington made measurements on the virgin and on the renewed bark of young budded trees of four clones. Tapping was done daily in alternate months on trees budded in the first half of 1924 and transplanted as stumps at the end of 1924. Records of bark thickness were taken on 23-28 July 1928 of parts tapped February 1, April 1, June 1, and July 20, and again taken on 14-18 January, 1929 of bark tapped at the same dates also on August 1, 1928. Fifty-eight trees from four clones were used in these experiments.

From figures given it may be quoted here that in January 1929 the bark tapped 1st February had a thickness of 5·0 mm. (clones B 50 and B 58), 5·0 (clone A 44) and 6·3 (B 85).

The conclusion is that bark renewal in the budded trees is satisfactory so far and that the bark is adequate for tapping.

Often difficulties have arisen from the fact that budwood of different clones had been confused and that budded trees have been planted out under erroneous names. The need was therefore felt to find characteristics which would enable to distinguish the different clones from each other. It was already well known that the seeds are often very characteristic and they have often been of great help in finding out mistakes. But seeds are not always available when we want to be certain to what clone a certain tree belongs and, besides, the seeds of different clones are sometimes much alike. For this reason the Rubber Experiment Station in Java has made a study to find other characteristics which might enable to distinguish the clone in a more satisfactory way. It was found that the form of the leaves, the shape of the leaf scars on the stem, the shape of the lenticles, the way in which the cork is formed on the stem, the shape of the stem, the shape of the buds, etc., are different in the different clones, and that the clones can

be determined with the help of these characters. For a successful determination some training is necessary. The Rubber Experiment Station in Buitenzorg gives regular courses in which the planters are trained in this determination work.

New figures of the best Sumatra-clones were given by Heusser.

Of the clones which have been in observation for several years the Nos. 49, 50, 71, 152, 163, and 256 may be considered as the best clones. The No. 36 is among the foremost as regards yield, but it has the drawback of being very sensitive to wind.

These excellent clones are closely followed as regards yield by Nos. 27, 35, and 53.

Among the clones which have been in observation only during the short time the Nos. 183, 185, 186, 209, and 214 justify full interest and accurate further observation.

The yields of these excellent clones are given in the following list. Tapping has been done alternate monthly (about 185 tapping days per year).

Table XV

Number of clones	Year of planting	Yield per tapping in grams					
		4th	5th	6th	7th	8th	9th year
49	1919	4·0	2·9	20·6	32·5	35·8	34·5
50	1919	6·1	14·7	30·3	34·0	29·5	31·1
71	1922	7·8	12·4	21 8	–	–	–
152	1922	9·7	17·1	23·6	–	–	–
163	1922	9·8	12·7	20·8	–	–	–
256	1920	?	?	?	?	41·7	–
183	1922	?	14·8	24·0	–	–	–
185	1922	?	21·1	35·1	–	–	–
186	1922	?	14·4	20·5	–	–	–
209	1923	–	13·5	–	–	–	–
214	1923	–	14·5	–	–	–	–

It is interesting to compare with these yields those obtained from seedlings from selected trees by artificial pollination.

Heusser gave an account of the tapping results of such seedlings. *Thirty combinations of different father and mother trees were investigated.* The number of trees of these combinations were different and varied (from three to eighty-three). They were all tapped with one cut over ½ circumference alternate-monthly. As father trees were used the trees 36, 49, 138, 145, 146, 140, 141, 142, 157, 164, 165, and 166; as mother tree Nos. 26, 35, 36, 49, 138, 139, 140, 142, 146, 151, 157, 161, 164, 165, 166.

Cross-pollination was effected in March-May 1930, the seeds were gathered in August-October of that year and the seedlings were planted into the field in October 1921-January 1922. Tapping was started in November 1925. The yields of a few of the best yielding "families" (as a

"family" are designated the seedling descendants of the same father-and-mother-tree) and the average yield of all the seedlings are given in the following list:

Table XVI

Number of father- and-mother-tree	Yield per tapping in grams			Number of trees tapped
	4th	5th	6th year	
157 × 164	10·19	28·19	34·65	32
165 × 161	7·1	24·53	31·65	4
157 × 151	12·73	27·70	30·43	3
164 × 161	7·98	22·34	29·60	28
166 × 161	7·38	23·44	29·21	4
Average of all the seedlings	7·30	18·63	20·24	724

These figures prove that some combinations of parents give seedling families which are not less productive than the best clones.

IDENTIFYING HEVEA CLONES *

REMARKABLE NEW METHOD DESCRIBED BY DR. BOBILIOFF

IN a preliminary communication to *De Bergcultures* (of 27 December 1930) Dr. Bobilioff describes what appears to be an entirely new and very important and remarkable chemical method of distinguishing between Hevea clones.

At present, he points out, a Hevea clone is identified by a subjective examination of the external morphological characters. This method has the advantage that in many instances a great number of buddings can be identified in a short time. It is, however, confined—at the moment—to normally grown buddings in a certain stage of development, and it demands as well as certain aptitude for this sort of work.

In the new "Chemical Method of Identification", on the other hand, the clones are distinguished by a definite chemical reaction of the latex. So far this method has been carried out only in experiments, and Dr. Bobilioff refrains at present from discussing how far it may have practical value.

His discovery is that the latex from each clone gives a definite chemical reaction and that this reaction is fairly constant in all individuals of a clone. One advantage of this chemical method of identification is that the identification is independent of the age of the plants, that is to say the latex from individuals of the same clone but of different ages will give the same reaction. Therefore it is possible to identify with clearness older test gardens.

In applying the method a few drops of latex are taken from young or half grown leaves by cutting through the leafstalk where it is attached to the branch. The drops that appear on the cut surface of the stalk are collected on a porcelain plate, preferably one with depressions. In each depression the latex from one tree of the clone that is being examined is collected. Three to five leafstalks will give sufficient latex for the reaction. To this small quantity of latex is added a reagent concerning which no particulars are given except that it is (1) a new discovery, (2) a colourless solution, and (3) the mixture of latex and reagent is white. In a short time, from half a minute to a few minutes, the latex begins to colour, and this colour increases in intensity.

The time of colouring, the nuances of colour, the intensity of the colour are different in different clones, so that it is possible to distinguish clones from each other.

---

* From *The India-Rubber Journal*, Vol. LXXXI, No. 12, 1931.

As an example Dr. Bobilioff takes three clones, namely BD 2, AV 256, and Tjir 1. After adding the reagent, the reaction occurs in about the same time for these clones. After one to two minutes the latex of these clones had assumed a rose colour, which in BD 2, and AV 256 is the same, but a careful examination indicates that in Tjir 1 a weak blue nuance appears to be present. It is in the second stage of the reaction that clear differences between these clones appear. The colour of Tjir 1 is pronouncedly blue, that of AV 256 is red and that of BD 2 is purple. These differences can be seen clearly in the third stage, that is from six to ten minutes. In these three clones the colour of the reaction can be used as a distinguishing character, while the intensity of the reaction and its time differ little.

There are, however, clones that can be distinguished merely by the intensity of the reaction, where, for example, the reaction is very weak and appears only after a long time. In the latex of AV 209 it is only after 45 minutes that a weak coloration begins to be apparent.

The method has been applied to a great number of clones in the experiment garden of the experiment station at Buitenzorg (Java) and also on several estates in West Java, where corresponding results were obtained.

RECENT EXPERIMENTS ON THE BURNING QUALITIES OF TOBACCO *

THE burning quality of tobacco is of special value for all kinds of tobacco used as wrapper. There are of course several other factors, which determine the value of a tobacco leaf as a cigar wrapper, but one of the most important is without doubt its fire-holding capacity.

The Journal of Agricultural Research has published an article on the influence of chlorine on the growth of the tobacco plant and its influence on the quality of the cured leaf. Experiments on light sandy soils and sandy loam soils in North Carolina showed a stimulation of the growth of tobacco by a moderate supply of chlorine in the fertiliser. Under the conditions of the place where the experiment was made a quantity of 22 kg. to 33 kg. per ha. caused the maximum of growth stimulation. It was demonstrated that the presence of chlorine in the soil enables the tobacco plant to make better use of the soil magnesium for nutrition and that a certain amount of chlorine in the leaf improves the resistance to drought. Larger quantities of chlorine however may cause injury to the plant, not by direct toxic effects but by interference with the metabolism of carbohydrates. This injury is more serious on light than on heavier soils. Tobacco leaves from chlorine fertilised plots exposed to various relative humidities after curing, showed that the moisture content was increased. This may influence its elasticity, its combustibility and keeping qualities. Excess of chlorine produced muddy colours in the cured leaf which often showed intermingled colours: green, yellow, brown. The combustibility of the leaf was impaired.

The Tobacco Sub-Station at Windsor (Connecticut Exp. Sta.) in its report for 1929 gives many details on various experiments on tobacco of which those connected with its burning qualities may be shortly reviewed.

Experience showed that dry seasons usually produced a tobacco with poor burning qualities and that the reverse happens when the season has a high rainfall. Analyses of the tobacco of a dry season and of a wet season showed difference in chemical composition, a good burning tobacco having less chlorine, calcium, magnesium, nitrogen, phosphorus, sulphur and manganese and more potash, silica, iron and alumina. A good burning tobacco has a much higher alkalinity than a poor burning one. Even the seconds, usually the best burning leaves, showed a greater alkalinity than the darks from the same plot.

Experiments with potash as a fertiliser showed, that the fire holding capacity of tobacco grown on plots without potash manure diminishes every year. Plots receiving potash however produced a tobacco which did not show any deterioration in this respect. The percentage of potash in the leaf was influenced by the quantity of potash manure, although the soil was very rich in this element. The percentage was increased by applying a larger quantity of potash fertiliser. When the percentage of potash decreased, the same was true in regard to calcium and magnesium in the leaf.

* From *International Review of Agriculture*, Part I, Year XXI, No. 12, December, 1930.

A general relation was observed between fire-holding capacity and the ratio of potash to calcium and magnesium, measured hy strip set. A wider ratio was favourable to the fire holding capacity. Differences in this capacity caused by the use of different potash salts, e.g., sulphate, carbonate or nitrate or by the use of tohacco stems, were very small. By applying sulphates to the soil, the percentage of sulphates in the leaves was increased and the burning qualities were weakened.

The Tobacco Experiment Station at Klaten (Java) started experiments on manuring to find a suitable method to apply green manure in relation to the peculiar rotation conditions in accordance with which tobacco has to be carried on. These conditions are only of local interest, but some results may have a more general significance. It has been proved by these experiments: 1. That quality and length were improved by organic manures (dung and green manure) ; 2. That on phosphorus poor soils length was improved more by dung than hy green manure, but that a small amount of P-fertiliser was sufficient to make them equal in this respect; 3. That P-fertiliser had a bad effect on the colour as it hastens the ripening of the leaf, especially in dry years and that not only on P-rich but also on P-poor soils (with only 0·004% cistr. sol. P_2O_5). Dung may therefore also have a bad influence as it contains a considerable quantity of P_2O_5; 4. The fire holding capacity was in general the best after green manuring (*Crotalaria* sp.) because the content of the dung in Cl. is considerably higher than that of the *Crotalaria*. But as the contents of *Crotalaria* augments with age, it should he applied as a green manure not later than after reaching flowering stage. 5. Experiments with fermented green manure showed improvement in length, quality, and colour. The same Station started a very thorough investigation in connection with the fire holding capacity of tobacco leaf, which may be of general interest.

(a) *Method of Examining Fire Holding Capacity.*—In order to examine the influence of various cultural practices on the fire holding capacity of the leaf, the average glowing duration was ascertained by noting, how many seconds each leaf continued to hurn, when lit hy means of a glowing carbon-point at the bottom of the leaf on the right side between two veins. In order to get sufficient reliability 800 leaves were burnt per test. Owing to the possibility of obtaining an average from a very large amount of experiments, this method was preferred to the "cigar-test".

Of the various burning qualities only the most important, namely the fire holding capacity, has been examined.

The figures thus obtained showed three types of frequency-distribution. The first with leaves of good fire holding capacity showed two summits: one not far removed from the arithmetic mean, the other as a result of leaves showing abnormal burning capacity. This made it impossible to apply the theory of probability and, as the investigation was started to find the causes of low-burning capacity, it was not necessary to spend time on it. The second type appeared by examining leaves with a very short glowing duration; it showed a flowing curve, of which the summit, as compared to the arithmetic mean, had largely shifted towards the side of the short glowing period. Provided that the frequency was expressed not in the time of glowing but in the logarithm of it, it was possible to employ the theory of probability to this case. The third type lay between the other two. The flowing curve did not deviate much from the binomial frequency-distribution and the theory of probability could be applied to observations of the glowing-time.

As the tests proved that the glowing duration was directly proportional to the logarithm of the percentage of moisture, it was possible to apply a correction for differences caused by moisture difference. It was proved that: $\log A - \log B = k \times (a\text{-}b)$ in which A represents the corrected glowing duration by a percentage of moisture, and b the moisture—percentage at the determined glowing duration B.

(b) *Chemical Composition of Good and Bad Burning Leaf.*—A chemical investigation of the leaf confirmed the previous observations that a bad burning leaf contained more chlorine and less potash than a good burning one. Although in most cases the percentage of chlorine in the ash was sufficient in itself to settle the matter, it was found that exceptions did occur and that besides the contents in potash, the contents in lime and magnesia were also of influence. The correlation coefficient between average glowing duration per leaf per plant and the amount of chlorine, sulphate, potash, calcium + magnesium expressed by the quotient

$$\frac{K_2O}{Cl \times (CaO + MgO)}$$

were calculated from the average glowing duration, computed for some nineteen separately harvested plants growing side by side in one test field and where thus the influence of different soil conditions was eliminated.

The correlation coefficients between the period of combustion and the proportion of the different mineral elements in the ashes of the leaves are shown in the following table:

	Mineral elements in the ash				
	Cl	CaO + MgO	K_2O	SO_3	$\frac{K_2O}{Cl \times (CaO + MgO)}$
Correlation coefficients	- 0·7	- 0 2	+ 0·4	0 0	+ 0·8

(c) *Influence of Manuring on Fire Holding Capacity.*—It has been proved, that the glowing period does not improve by fertilising. Among the organic fertilisers it was found that straw manure (fermented rice straw) and dung most seriously harmed the glowing capacity of the leaf. Oilcakes (kapok seed, coconut, groundnut, etc.) and *Crotalaria* choppings used as green manure had little or no injurious effect. The injurious effect was closely associated with the amount of chlorine in the organic fertilisers.

Also the usual inorganic fertiliser, sulphate of ammonia, if necessary supplemented with double superhosphate, is detrimental, although to a less degree than dung. Contrary to what was expected after the chemical examination of the tobacco, no improvement was recorded after the use of potash fertiliser.

(d) *Influence of Soil Conditions.*—The occurrence of non-burning tobacco was found to be most prevalent in places where quantities of chlorine existed in the soil moisture. It is therefore probable that all measures to soil-capillaries will be of value, whereas those precautions that tend to increase these soil capillaries will prove disadvantageous. In fact the early inundation of the soil, by which the soil particles are able to coalesce more closely, has disastrous results on the fire holding capacity.

(e) *Breeding Good Burning Varieties.*—A large number of plants grown side by side or close together under identical circumstances and harvested separately, showed that great differences are to be found with regard to the average glowing period per plant.

The hereditary character of these differences was also proved.

Among the chief practical measures for the improvement of fire holding capacity the following may be mentioned:

1. Improvement of drainage and system of tillage. 2. Replacing dung by green manure. 3. Avoidance of all not strictly necessary flooding. 4. Careful adaptation of sowing and transplanting dates to weather-forecasts. 5. Some reduction in planting distance. 6. Avoidance of excessive heating in the drying sheds.

(f) *Influence of Climate.*—Burning capacity however does not depend only on soil factors as climate also plays an important part. The Experiment Station of Scafati (Italy) started in 1929 an experiment to prove the influence of climate on combustibility of Kentucky tobacco. In the community of Bibbiena second class tobacco is produced and in the Valle di Chiana only a fourth class. Four wooden cases, each about ½ m^3 were filled with earth, two of them with soil from Bibhiena and two with soil from Chiana. The two containing Bibbiena soil were transported to Chiana and placed in a field at Chiana and with the other two the process was reversed. It was possible in this way to cultivate tobacco in Chiana soil at Bibbiena and vice versa at the same time with the surrounding tobacco plants growing in untouched soil.

The result has been that the tobacco cultivated in Chiana soil at Bibbiena has not been influenced by the climatic conditions of that place; in regard to its combustiblity it belonged also to the fourth class, as that grown at Chiana itself. The tobacco cultivated in Bibbiena soil at Chiana however was influenced by the climatic conditions: it belonged also to the fourth class while at the same time the same tobacco grown at Bihbiena produced a second class product.

THE CLOVE INDUSTRY IN ZANZIBAR *

(*A*) *Production.*—It is impossible to deal with the industry of paramount importance to Zanzibar—clove growing—in a report confined to events falling within the calendar year. That report, written in October last, carried the review of the industry up to end of June, 1929, and indeed it was possible to remark upon the commencement of the 1929-30 harvest.

In this report we are, therefore, concerned with the season commencing in July, 1929 and terminating for statistical purposes at the end of June, 1930.

The previous season—1928-1929—having been an unusually poor one, cloves brought to town during July to June having amounted to only a trifle over two lakhs of fraslas (say 3,100 tons), it was only to be expected that the 1929-30 season would be unusually good. Expectations were realised and the season established a record.

Exactitude in statements of the measure of crops is an impossibility. Even when all cloves produced in the country had to pass through the Customs on entering town for the purpose of excise it was not necessarily the case that all the cloves picked between July and February, the normal limits of the harvesting period, were brought to market between July and the end of June, nor that all the cloves brought in during that period belonged to that particular harvest. I have known four-year-old cloves brought into town from the plantations, though this is very unusual.

Estimates have to be made of stocks from previous years brought in and hold-overs carried by the producers. Although old stocks coming in can be distinguished from new season's produce it frequently happens that, being drier, they are mixed with the new to enable the bulk to pass the standard required by the Produce Export Decree. As an estimate of the season's crop is fundamentally based upon the deliveries at the Customs, and such was not obligatory during the past two seasons, excise having been taken at the time of export only, even the fundamental data have been lacking in the accuracy of former years. The clove deliveries we may characterise as the raw figures to distinguish them from those which the Comptroller of Customs prepares to represent so far as can be ascertained by the quantity produced during the season.

In the season 1928-29 the deliveries were given as 200,568 fraslas, and during 1929-30 as 928,943. The latter raw figure requires various adjustments to allow for hold-over and parcels brought to town but not passing through the Customs House for weighing, and the Comptroller of Customs is of opinion that the season's production must have reached at least 10 lakhs of fraslas (over 15,500 tons) and therefore have beaten the previous record of 9·8 lakhs in the season 1922-23. Early in 1930 it was realised that the succeeding crop would be an almost complete failure.

The tremendous variation in size of crop from season to season has not so far received an explanation. Precisely what effect it would have upon the market if future crop could be foretold it would be difficult to say. Speculation quickens interest, and the uncertainty of the future position must necessarily lead to competition in buying stocks. There is probably hardly another crop in which it is such a gamble to deal. Growers and

---

* From the Annual Report of the Agricultural Department of Zanzibar Protectorate for 1929.

merchants alike must speculate on the probability of the next crop and it is in vain that we look through the records of the past to give us a clue to the future.

An apparently safe system for the producer to adopt is to hold a proportion of his crop in years of great plenty; to hold very little when the crop is average and to sell that at the first sign of a large succeeding crop; to sell hold-over gradually and not expect to get the top price of the year for the whole of it.

Before attempting to peep into the future it is well to consider this question of variation in size of crop critically.

When I visited Singapore in 1924, the Director of Botanic Gardens there drew my attention to some clove trees which, though quite well developed, practically never produced a bud, whereas at Penang, about 380 miles way, clove production is an important industry which leads the world as regards quality. Mr. Birkill expressed the view that the difference in behaviour of the trees in the two islands was capable of a simple explanation, viz., that in Singapore the climate is uniformly moist whereas in Penang there are distinct dry periods, as in Zanzibar, and that this stimulus is necessary to cause the trees to flower.

Now were flowering a simple reaction to a climatic stimulus there would be no difficulty in correlating crops with meteorological observations, but so far a correlation has not been found. The Dutch botanists who have studied the tree in its native habitat state that the clove only flowers twice in three years and will bear heavily once in from four to seven years. Periodicity in flowering is a general phenomenon, that it to say that flowering plants have a tendency to flower at certain periods apart from any external stimulus. The coconut palm flowers every 26 to 30 days, many plants flower twice a year, some annually, others only once in their existence. The clove tree appears to have an obscure periodicity so that the effect of the external stimulus—climate—is obscured. The same stimulus will only produce the same reaction if the tree is in the same phase. There is also a clear indication that when the external stimulus acts upon the trees when in a phase preparatory to flowering an abnormally large crop results, but a reaction follows, presumably due to temporary exhaustion, and the trees will completely miss flowering for a season. There is a kind of oscillation produced and the pendulum does not come to rest at once, large and small crops alternating for perhaps four seasons.

We have probably three factors to take into consideration:

(1) The nature of the climatic stimulus.
(2) The phase in the periodicity of the trees.
(3) The reactions from a previous stimulation.

Obviously unless these factors are known and measured the resultant—the future crop—cannot be predicted.

During the first half of 1930 the trees certainly received a stimulus in the way of a dry period, and some of them will unfortunately never flower again. The dry period—May to August—was, however, not altogether seasonable, and it does not appear to have produced any tendency on the part of the trees to produce buds for the December-January portion of the crop. How many weeks or months pass before the effect of a stimulus is visible to the eye is not known, so that were we more certain even of its nature we should still be unable without further knowledge to gauge the effect upon a forthcoming crop whose size may be affected by the conditions obtaining only during a particular and short interval of time.

Our peep into the future—the season 1931-32—cannot therefore be made with anything approaching safety. We do not know how the past, present, or future climatic conditions will modify the trees' inherent tendency. There has been a violent oscillation, two lakhs, ten lakhs, the present (1930-31) crop of less than two lakhs. The oscillation would tend to carry the future crop upwards, but it is obvious that we are too near the last phase of the heavy bearing period for it to appear again, and a rather above average, say 6½ lakhs, crop would appear to be the most probable event.

In my last annual report attention was drawn to what appeared to be the repetition of a previous cycle, and the following figures will be found of interest :

Season	Fraslas	Season	Fraslas
1913-14	7,83,680	1924-25	7,61,412
1914-15	5,26,309	1925-26	6,11,814
1915-16	7,96,757	1926-27	7,33,209
1916-17	5,11,635	1927-28	6,90,752
1917-18	2,98,197	1928-29	2,00,568
1918-19	8,24,502	1929-30	10,00,000
1919-20	2,62,550	1930-31	1,75,000
1920-21	5,48,277	1931-32	6,50,000
1921-22	2,66,802	1932-33	?
1922-23	9,81,915	1933-34	?
1923-24	3,11,794	1934-35	?

The chief object in discussing the apparently fortuitous variations in the clove crop is to draw attention to the nature of the problem in the hope that observers in this and other countries will give some attention to the *matter. It is possible that experience elsewhere with fruit or forest trees* may put us in possession of the means to unravel the knot, and suggestions would be most gratefully received.

(*B*) *Finance.*—It is inevitable that violent fluctuations in production should be accompanied by corresponding fluctuations in price. Some idea of these fluctuations will be gathered from the following figures of the average price of Zanzibar cloves for the month, with duty added.

Date	Duty paid price Rs. per frasla Rs. Cts.
1929	
January	30 98
March	33 91
June	31 95
September	16 50
1930	
January	14 74
March	18 65
June	19 84
September	22 21

There has during the past two or three years been a movement on foot in many parts of the world to stabilise production with the object of steadying prices. The general principle of making the supply fit the demand; of managing that the production is economically carried out; and of arranging that the consumer is supplied regularly at a price satisfactory to all parties, has been called "Rationalization."

To what extent this principle can be applied to the Clove Industry has been the subject of much thought by many minds. In the early part of the year under review a Committee was appointed to consider the matter generally. That Committee did not reach any agreement but the views which were expressed by members, in many cases very divergent, were subsequently published with the object of stimulating thought upon the matter.

Possibly the word "Rationalization" is unfortunate. It cannot be translated into Arabic or Kiswahili in thought or word. The general impression gathered by the producers was that cloves should be "rationed" like food to soldiers, and the idea left them wondering. It was generally considered that we were dealing with a very difficult and abstruse matter, and the more the subject was discussed the further we appeared to get from understanding it. A speck of dust under the microscope becomes a boulder, and the smoothest pavement a land of impenetrable mountains.

Laying aside the rationalizer's microscope this simple issue appears:

Production of cloves cannot be stabilised. If the producers find it inconvenient to have a good income one year and practically none another they must not sell all their cloves at one time. If the consumers find it inconvenient to pay 1s. 6d. per lb. for cloves one season and 9d. per lb. another they must buy more freely when cloves are plentiful. One or the other must hold stocks. Whoever complains has the remedy in his own hands.

If the producers and consumers were rational the question of rationalizing the industry would not arise. It would not seem unreasonable to put our own house in order before attempting to dictate to people overseas how much and when they should buy.

Comparing the two seasons 1928-29 and 1929-30, the former a two lakh crop and the latter in the region of a ten lakh crop, the average selling prices per frasla duty paid during the twelve months of each season were in the former Rs. 28-15 for Zanzibar and Rs. 27-98 for Pemba, and in the latter Rs. 18-29 for Zanzibar and Rs. 17-55 for Pemba. Considering the size of the 1929-30 crop the prices were very satisfactory and could not have been maintained had there not been a very distinct effort at internal "rationalization" in the shape of holding over stocks. It is estimated that something like 2½ lakhs of fraslas (3,900 tons)—more than twice the maximum production of Madagascar (our only serious competitor)—were held from the market. This indicates the strength of our position in the producing world.

During the twelve months ending June, 1929, Zanzibar had exported 7·48 lakhs (11,700 tons) and Madagascar ·54 lakhs (850 tons) of cloves. Neglecting the smaller contributions from other countries (perhaps 400 tons) it is evident that at least 12,550 tons of cloves were bought during the period *in which the Zanzibar price was about Rs. 18 per frasla duty paid.*

Overseas stocks do not appear to have increased and there is every appearance of this quantity having been actually consumed.

The twelve months July 1930 to June 1931, will have available some

3,900	tons Zanzibar hold-over
3,000	tons Zanzibar new crop
1,500	tons Madagascar
8,400	

This estimate shows that world supplies are 33 per cent less than the previous twelve months' consumption. At the moment of writing the duty paid price of Zanzibar cloves is about Rs. 24 per frasla. It would undoubtedly have been much higher had not the very important Indian market been dull owing to the general trade disturbance.

(*C*) *Inspection of Cloves.*—The Agricultural Produce (Export) Decree, 1929, came into force on August 17th. The object of this Decree is the same as that of the Agricultural Produce (Adulteration) Decree, 1927, which it revoked. The new legislation was necessary as experience had shown that the earlier decree was faulty, particularly in regard to fixation of responsibility as between owners, agents, shoppers, etc. Under the first decree it was an offence to deal in cloves which did not comply with the standards of quality laid down. Control could be exercised from the plantation to the wharf. The present decree limits control to the wharf, and therefore greatly reduces the amount of work involved in inspection. Refusal to permit exportation is the only punishment in the case of produce unfit for export being offered, but that this is a sufficient deterrent from attempts to ship such produce will appear from the following:

	August 17th to December 31st, 1929.		
	Examined	Passed	Failed
Consignments	1,139	1,115	24
Bales	91,955	89,320	2,635
	January 1st to June 30th, 1930.		
	Examined	Passed	Failed
Consignments	857	848	9
Bales	60,624	60,127	497

Of the 1,52,579 bales of cloves, representing 1,996 consignments, examined between 17th August, 1929, and 30th June, 1930, 97·9 per cent passed, these representing 98·3 per cent of the consignments.

The rapidity with which merchants adapted themselves to the new conditions imposed upon them by the decree is remarkable, but it must be remembered that the previous Adulteration Decree had already effected a tremendous improvement in the quality of produce coming into the market.

The members of a Committee advising upon the nature of the new decree were divided in opinion as to the desirability of retaining powers of control before the actual time of export, some fearing that the producers would not respond to the law unless pressure were applied directly to them with the result that the onus of conditioning cloves would fall upon the exporter and that he would necessarily give a very low price for produce desirously below or suspiciously near the standards prescribed. Particularly was this fear felt in regard to Pemba cloves as the producers were further away from the point of export and their produce would have changed hands many times before it was subject to examination.

How far these fears were justified will appear from the following figures supplied by the Comptroller of Customs:

(a) Before the Export Decree came into force

	Rupees per frasla		
Period	Zanzibar	Pemba	Difference
	Rs. Cts.	Rs. Cts.	Rs. Cts.
1925-26	16 83	16 86	0 03
1926-27	13 77	13 71	0 06
1927-28	12 85	12 64	0 21
1928-29	28 15	27 98	0 17

(b) Decree published

1929			
July	20 07	19 07	1 00

(c) .Decree in force

	Rs. Cts.	Rs. Cts	Rs. Cts.
August	16 00	13 02	2 98
September	13 20	12 20	1 00
October	14 51	13 57	0 94
November	12 96	12 16	0 80
December	12 26	11 64	0 62
1930			
January	11 44	10 90	0 54
February	12 20	11 82	0 38
March	15 42	15 35	0 07
April	18 61	18 53	0 08
May	17 66	17 38	0 28
June	16 71	16 54	0.17

(July 1929—June 1930, Excise Duty Rs. 3-30 to be added).

These figures do not represent the extreme fluctuations caused by the decree, but they enable a measure to be taken of the loss to Pemba through its failure to meet requirements. On the quantities changing hands the loss during the year must be in the neighbourhood of four lakhs of rupees.

The plantation owners undoubtedly prefer to lose money than to be subject to direct pressure and the above figures whilst indicating how severely they have punished themselves also show that after about six months they recovered their position.

From time to time the question of grading cloves has been raised. It is perhaps not fully understood in the overseas markets what is the precise nature of the Government control in Zanzibar. Formerly cloves were frequently shipped quite wet, due either to careless preparation, deliberate adulteration, or accidental damage by rain or sea-water. Also large proportions of stems and other foreign matter were frequently present, again due either to careless preparation or deliberate adulteration. The inspection at present is directed exclusively towards preventing the exportation of cloves containing more than 16 per cent moisture or 5 per cent foreign matter. Although the decree provides for rules being made for prescribing grades of quality such rules have not been laid down. It must clearly be understood, therefore, that a certificate of quality under the decree only takes account of these two factors and does not purport to reflect upon the quality of the produce from any other point of view. Weather-beaten wind-fall cloves, the colour of ashes, swept up from the ground at the end of the harvest will, if they contain less than 16 per cent moisture and 5 per cent foreign matter, pass the test.

The Zanzibar Chamber of Commerce has recently given careful consideration to the advisability prescribing a limit to the proportion of withered cloves (locally called Khoker) which shall be permissible in cloves. At first sight this appears to be a sound and simple proposition. If ordinary or normal cloves were of a regular and definite appearance the addition of khoker could be detected and its amount determined. Unfortunately the appearance of normal cloves varies very greatly depending upon the precise stage of ripeness when gathered from the tree and upon the climatic conditions and methods of handling obtaining during the dry period.

If there is wet weather during a heavy harvest the producer is unable to protect his cloves. Heaped in sheds they degenerate and if left spread out in the rain the colour is washed out of them. Under these circumstances a large proportion of the crop becomes wrinkled and discoloured and, in fact, indistinguishable from the khoker obtained from plantation sweepings.

When the bulk of a sample is bold and bright, with a proportion of dull, wrinkled and discoloured cloves, it is obvious that the material has not been wholly prepared under the same conditions and is therefore a deliberate blending. The proportion of each quality present can easily be determined. When, however, the bulk is dull and discoloured it is impracticable to make any definite separation on an appearance basis.

The quality of a sample should be gauged by

1. Dryness.
2. Freedom from foreign matter.
3. Colour (reddish-brown, dark-brown, black, dull or bright).
4. Form (with or without crown, smooth or wrinkled, etc.).
5. Size (weight per 100 cloves).
6. Oil content.

The present inspection guarantees a product satisfactory as regards 1 and 2. If grading were established 3, 4, and 5 would have to be taken into consideration and the grades determined in relation to these factors. Item 6, perhaps the most important one of all—it is the oil in the clove which alone gives it any value whatsoever could not be undertaken as part of any general inspection, but the oil content of any sample can be obtained on payment of a fee.

In the grocery trade, including in that term the supply of cloves for all culinary and chewing purposes, colour, form and size, are important factors. The oil distiller can have no real interest in anything beyond the oil content, though he may perhaps, mistakenly regard the general appearance as a good guide to that point. The spice grinder is more interested in the oil content than in anything else as it is this which gives strength to the spice. Colour, however, may be some consideration to him.

Government is quite willing to undertake any grading which can be shown to be in the best interests of the industry and of this country. It is obvious that the consumers should indicate their requirements and to what extent they are prepared to pay a premium for the particular quality of produce which best meets their need. The producer would be prepared to offer fair-average-quality and premium cloves, the buyers would doubtless prefer fair-average-quality and discount cloves!

I have frequently observed very small differences in price between samples at the opposite ends of the scale. At the present moment with cloves at Rs. 24 per frasla duty paid, half a rupee is only 2 per cent of the price but represents buyers' opinion of the difference in value between the best cloves obtainable and some quite inferior produce.

Is grading therefore really required?

For the present at any rate the consumers must rely upon their agents or shippers to select for them the quality which they require. The best cloves are bought for the best price. If the consumer pays that price but gets "Khoker" he should change his agent. There are many firms in Zanzibar with long experience in shipping cloves to all the markets of the world and the Chamber of Commerce would always provide a list of such merchants on application.

(D) *Artificial Drying of Cloves.*—Rumphius, the 17th Century Dutch botanist, states that in his day cloves were covered with leaves and for some days subjected to a smoky fire. That was in Amboyna, the home of the clove. Nowhere in the world does fire-drying of cloves appear to be practised at the present day.

The question of artificial drying of cloves has been considered in this country from time to time, the first recorded experiments having been carried out by Mr. Lyne some twenty-seven years ago, though at a much earlier date hot-plates had been advocated but, so far as I know, not tried in practice. The 1903 experiments were more particularly tests on drying under glass, which process Mr. Withycombe is again exploring.

The Department of Agriculture experimented with fire-drying during the 1927-28 and 1928-29 seasons, reference to which was made in the previous annual report. During the 1929-30 season the crops on the Government Plantations were leased and there was no opportunity of carrying out field experiments on the subject; laboratory tests were, however, made to ascertain safe temperatures for drying so that loss of oil should not ensue. With the coming into force of the decree prohibiting the exportation of cloves containing more than 16 per cent moisture it was anticipated that some form of conditioning plant in the town would become necessary.

The merchants were quite convinced that it would be impossible for them to bring the cloves into condition for export—they then proceeded to do it! For a month or two Zanzibar was tronsformed into a drying ground. Public and private open spaces, school playgrounds, roofs of houses, even roads and foot-paths, were covered with drying mats and cloves. The merchants certainly made the careless producers pay for the trouble involved, but their enterprise in carrying out the conditioning was admirable. During the period from the commencement of the decree, 17th August until 31st December, there was a normal amount of rain and a lot of wet cloves were brought into town (as witness the variation in price referred to) and yet of the 91,955 bales examined, only 2,435 were rejected on the score of moisture. Of these 1,328 were removed from the Customs, dried and replaced, in time to catch the ships by which they were intended to be shipped. *Only 1,107 bales (1·2 per cent) of all the cloves brought to the wharf during this period actually missed shipment on account of excessive moisture.*

The producers have, since August 1929, learned something of their lesson and it now seems doubtful whether money spent on a mechanical drier would be a good investment.

The department invoked the aid of the Imperial Institute in ascertaining the probable outlay necessary to provide drying machinery for conditioning cloves. The proposals of a number of firms have been received but of their suitability for clove drying there is, of course, no experience.

It was intended to make further experiments to test the applicability of the different systems of drying to our produce, but the clove harvest ended so abruptly that green cloves became unobtainable before much could be accomplished.

The conclusions arrived at were:

1. Hot air drying by natural draught is unsuitable. Quick drying is essential to obtain a good colour and air must be either at too high a temperature or else be under forced draught to remove the moisture at a satisfactory rate.

2. Drying on mats over a sand-bath type of kiln such as is used on Government plantations for preparing copra is very successful if the green cloves are spread at the rate of 1½ lb. per square foot, turned over at intervals, and the temperature not allowed to rise above 60° Centigrade. Under these circumstances the cloves dry out to a moisture content of 10 per cent (drier than required by the decree) by the end of the second day—actually only being hot for about 12-15 hours—and present a very good appearance, better in fact than the sun-dried article.

   Analysis of material thus produced shows that there is no material loss in oil our material yielded 19 per cent essential oil with slightly less than 10 per cent moisture.

It is proposed next season to utilise the copra kilns on Government plantations whenever the weather interferes with sun-drying. It is worthy of note that after the first few days of careful attention by Mr. Raymond or myself the kilns were left entirely in the hands of the native plantation staff and not a single clove was damaged. The remarks on this subject in my last annual report were too pessimistic though it must be remembered that our native staff is perhaps more disciplined than that found on plantations generally.

The natives themselves were enthusiastic over the matter and consider that we need no longer trouble about the weather in clove harvest time. The produce commands a premium on the market.

(E) *Regeneration of Clove Plantations.*

(F) *Local Distillation of Clove Oil.*—Attention has continued to be paid to these important matters and it is confidently hoped that before the end of another year definite knowledge of the economic position in relation thereto will have been acquired.

MEETINGS, CONFERENCES, ETC.

RUBBER RESEARCH SCHEME CEYLON)

MINUTES of a meeting of the Board of Management held at 10 a.m. on Thursday, February 19, 1931, in Committee Room No. 1 of the Legislative Council Chamber.

Present: The Hon'ble Dr. W. Youngman (in the chair), Messrs. A. S. Collett, A. E. de Silva, B. F. de Silva, C. E. A. Dias, J.P., J. Farley Elford, J. A. D. Finch Noyes, the Hon'ble Mr. H. R. Freeman, Messrs. F. H. Griffith, J. D. Hoare, C. A. Perera, D. C. Senanayake, and Mr. J. I. Gnanamuttu (Secretary).

Apologies for absence were received from Mr. C. W. Bickmore and Colonel T. Y. Wright.

Mr. T. E. H. O'Brien, Chief Technical Officer, was present by invitation.

The Chairman announced that the House Committee of the Legislative Council had allotted a Committee Room for the use of the Board until the introduction of the New Constitution. The Board appreciated this action of the House Committee and recorded its thanks.

1. MINUTES

The minutes of the meeting held on December 5, 1930, copies of which had been circulated to members of the Board, were taken as read and were confirmed and signed by the Chairman.

2. ANNUAL MEETING

The Chairman submitted that, as the funds of the erstwhile Rubber Research Scheme were expended up to December 1930, the annual report and balance sheet would be presented to a general meeting of the subscribers as had been done in the past years. It was also necessary to obtain the consent of he subscribers to handing over the assets, liabilities and staff of the Old Scheme to the Board of Management. Mr. Farley Elford suggested that the views of the old subscribers regarding the appointment of a Director of Research might be useful. Mr. B. F. de Silva submitted that the Board of Management had full authority in the matter. It was decided that the Board should take all responsibility for appointments. Mr. Dias stated that a date in April had hindered a fair attendance at past general meetings and proposed a date in March. The Board approved provisionally of March 26, and desired that the draft report and balance sheet be circulated as early as possible to members of the old Executive Committee and of the present Board of Management.

3. ACCOUNTS

(a) The statement of receipts and disbursements of the Board of Management for the quarter ended December 31, 1930, was passed. The statement showed a credit balance at that date of Rs. 79,713·09.

(b) The statement of receipts and disbursements of the London Advisory Committee for the quarter ended December 31, 1930 was passed. The statement showed a credit balance at that date of £49.3.11.

The Chairman reported that £500 had been remitted to the London Advisory Committee in the current year and proposed that a further sum of £1,000 be now remitted to finance the work in London up to the middle of the year.

(c) The Chairman read the following suggestion from Messrs. Duncum, Watkins, Ford & Co., the auditors of the Old Scheme :

"*London Vulcanising Plant.*

We would suggest that this be written up to the equivalent of £850 which is the valuation which the London authorities placed on this plant in April 1930, and that the excess over the present book figure be credited to a London Plant Reserve Account and we shall be glad to hear if you approve of this. The present book figure is Rs. 4,849·64 and this procedure would result in this asset being increased to Rs. 11,333·34 (viz: £850 at Exchange 1s. 6d.)."

In reply to Mr. Dias the Chairman stated that the suggestion involved only a book transaction. Mr. Collett supported the auditors' view. The suggested procedure was sanctioned.

4. STAFF

(a) *Director of Research.*—Copies of the advertisement sent out for publication in two consecutive issues of "Nature" were circulated. The Chairman stated that copies would be posted to institutions and individuals likely to be interested in the appointment. At Mr. B. F. de Silva's suggestion, the Board approved of the advertisement being inserted twice in the London "Times". It was mentioned that Mr. R. G. Hatton of the Horticultural Research Station, East Malling, Kent, would arrive shortly in Ceylon and might be able to help with suggestions. The Chairman stated that he would consult Mr. Hatton.

With regard to the posts of Physiological Botanist and Geneticist, the Chairman submitted that it would be advisable to defer the advertisement to a later date.

(b) *Chemist.*—The Chairman reported that Mr. T. E. H. O'Brien had asked that his new agreement should be on the same lines as those of the Tea Research Institute, and that the Coconut Research Scheme was adopting the same policy. Mr. B. F. de Silva suggested that the draft of the proposed agreement be submitted to members of the Board of Management. The Chairman stated that the lawyers of the Scheme who were to be nominated that day, should be consulted, and undertook to circulate the draft agreement as settled by the lawyers.

A letter from Mr. O'Brien was read suggestng that 3 months' home leave be granted to him as from April 22, and that the balance of leave due to him be availed of after the new Director of Research had settled down. The Chairman recommended that the extra passage cost involved be accepted in view of the consideration Mr. O'Brien had shewn for the interests of the Scheme and his conscientious work. Mr. O'Brien was then called in and questioned whether it would be advisable for him to take, say six months' leave straight away. Mr. O'Brien replied that a good many things could be shelved during an absence of three months, but a hiatus of six months might prove detrimental to the Scheme, although in his personal interest a longer period of leave would be acceptable. Mr. Dias submitted, now that Nivitigalakele Station was greatly improved, the Scheme might mark time till it secured its full staff, and seeing that most of the estates were not doing much work, the Board could spare Mr. O'Brien at the present time. It was resolved that the full leave due to Mr. O'Brien be granted to him now at one stretch, and that a fresh agreement with the new Board be drawn up. The Chairman mentioned that the erstwhile Executive Committee had agreed to allow Mr. O'Brien, in the event of his continuing in service, the same leave privileges as were enjoyed by permanent employees of Government. The Board agreed that the period of leave allowable under these conditions be determined by Mr. Bickmore.

Mr. Dias suggested that at future meetings the Chief Technical Officer be called in only when his advice was necessary upon any particular item on the agenda. This was agreed to.

(c) *Mycologist.*—The Board approved of the provision of a free passage for Mrs. Murray when Mr. Murray, who married recently, was due for home leave.

(d) *Agricultural Assistant.*—A letter from the Chief Technical Officer recommending that the services of Mr. Pieris be retained by the Board was read. The Chairman stated that Mr. Pieris had been appointed for a period of six months, and it was difficult to say at present what position he should occupy in the permanent scheme. Mr. Dias suggested that Mr. Pieris should continue in his temporary appointment until the arrival of the Director of Research. Mr. A. E. de Silva urged that Mr. Pieris should be offered a permanent appointment, considering his qualifications and the work he had done. He proposed that the Board should enter into an agreement with Mr. Pieris as Agricultural Assistant, subject to his transference to any other post in which he might be required by the Director of Research with the sanction of the Board. Mr. Senanayake seconded the motion and it was carried.

(e) *Provident Fund Scheme for the Staff.*—The Chairman informed the Board that the Coconut Research Scheme had requested Mr. Bickmore to draw up a Scheme of Provident Fund. The Board resolved that a similar Fund for both the Schemes was desirable and that Mr. Bickmore be asked to draw up such a scheme.

5. EXPERIMENT STATION

(a) The following resolution was moved by Mr. Dias:

> "That the Board should take immediate steps to secure the forest land of three hundred odd acres in Pasdun Korale, Kalutara District, offered by Government to the Rubber Research Board for rubber research work."

Mr. Dias urged that the land at Liniyawa be secured, but that the utilization of it be deferred for further consideration. The Chairman drew attention to the memorandum of the Chief Technical Officer which had stressed the necessity of experiments upon the rejuvenation of an existing estate in preference to the planting up of new land. There was an estate which appeared to be suitable between Culloden and Nivitigalakele with an area of Crown jungle in proximity. This would keep the work in a compact area. Mr. Dias urged that it would be easier to prove a clone with new land than with old land, and new land could be bought very much cheaper. He thought that, for the purpose of rejuvenation, Nivitigalakele might be considered an old estate. The most pressing matter was replanting in its various aspects, and estates of varying types of soil would be wanted for that purpose—possibly estates in different localities. After further discussion, it was resolved that the reservation by Government of the 300 acres of forest land at Liniyawa for the purposes of the Scheme, be ensured, but that such acceptance should not involve any obligation to develop this land until the Board was in a position to do so. The Chairman was asked to interview the Colonial Secretary and to report at the next meeting whether or not this land would be reserved for the Scheme on such conditions. Mr. Dias further suggested that the Colonial Secretary be asked what other Crown land may be available for the purposes of the Scheme.

It was further resolved that investigations be undertaken into the question of rejuvenation of existing rubber. Mr. Griffith mentioned there was planted land available round about Moragalla. Mr. Dias stressed the

necessity of knowing one's clones before attempting rejuvenation, and suggested that as Dr. Cramer would pass through Colombo in May next his advice be sought as to how the Board should proceed. The Chairman enquired if there was any possibility of new land being opened out in Ceylon, and members doubted such possibility. Mr. Collett urged that as the persons who now provided the funds of the Scheme were the existing estate owners, the investigations of the Board should be principally in their interest. The view was accepted that the acquisition of developed land for the purpose of rejuvenation experiments was of immediate necessity.

It was proposed by Mr. Griffith, seconded by Mr. Farley Elford, and carried unanimously: that a Committee be appointed to take immediate steps to ascertain what properties were available for purchase for the purpose of experiments in rejuvenation in the rubber-growing districts. Mr. Collett proposed that the Committee should consist of Mr. F. H. Griffith (Convener), Mr. C. E. A. Dias, and Mr. B. F. de Silva, This was seconded by Mr. Freeman, and carried. Mr. Dias suggested a limit of about 50 acres each in (1) Matale, (2) Kelani Valley and Kegalle and (3) Kalutara Districts, and that no estate be visited until after the Committee had reported to the Board. This was agreed to. The Secretary was directed to communicate with District Planters' Associations, notifying them that it was the intention of the Board to undertake rejuvenation experiments on three small areas of old rubber and that the Board was prepared to consider offers of land of 50 to 100 acres. All offers received to be forwarded to the Estate Committee in the first instance.

It was understood that the working of three stations at the same time was a question of finance, which should receive consideration before any estate could be purchased.

(b) *Building of Bridge.*—The Chairman reported the completion of the bridge on the Nivitigalakele Experiment Station approach road, under the supervision of Mr. F. G. C. Busby, at a cost of Rs. 3,252·06, and suggested that Mr. Busby be thanked for his assistance and paid an honorarium to meet his out-of-pocket expenses in petrol, etc. This was agreed to, and on the motion of Mr. Freeman, seconded by Mr. Senanayake, an honorarium of Rs. 300 was sanctioned.

(c) *Accounts of the Experiment Station.*—The Chairman invited the opinion of the Board whether the detailed monthly expenditure statements of the Station should continue to be circulated to members. It was decided that circulation was not necessary, but that the accounts be tabled at the meetings of the Board and be available for inspection by any member at any time.

(d) *Assignment of the Lease of Nivitigalakele.*—The legal position of the Board regarding the Crown land at Nivitigalakele in favour of the erstwhile Rubber Research Scheme was referred to the opinion of the lawyers of the Scheme.

6. REPORTS

(a) The progress reports of the technical officers for November and December 1930, and January 1931, copies of which had been circulated, were passed without comments.

(b) A report by Messrs. G. Martin and L. E. Elliott upon "The Cause of Variability in the Plasticity of Plantation Rubber After Storage" copies of which had been circulated, was noted.

(c) "A Report on Diseases and Pests of Rubber, 1930," prepared by Mr. Murray for the Kalutara Planters' Association, was tabled.

7. TESTS OF PROPRIETARY PRODUCTS

A memorandum submitted by the Chief Technical Officer, together with a certain draft procedure was read. The Chairman suggested that any hard-and-fast rule would not be advisable, that, as a general policy, the Scheme should refuse to carry out tests, but that each application might be considered on its own merits. It was decided that in the case of any costly article reference should be made to the Board, tests of small articles being left to the discretion of the Chairman or the Chief Technical Officer. Under no circumstance should manufacturers be permitted to use any report of the Scheme for the purpose of advertisement; no report on any proprietary article or machine should be made by the staff without the sanction of the Board.

8. LAWYERS OF THE SCHEME

(a) Mr. Dias proposed that Messrs. F. J. and G. de Saram be appointed lawyers of the Board. Mr. Senanayake seconded.—Carried.

(b) *Seal and Crest.*—The Board desired that the design of the Ceylon crest be adopted, with an elephant and a rubber tree; a fresh drawing to be submitted at the next meeting.

9. PUBLICATIONS

(a) A letter from the Secretary of the London Advisory Committee asking that 57 copies of the Scheme's publications should continue to be supplied for circulation to members of the Committee, to technical journals, and to Government departments and other organisations in London with whom arrangements for the exchange of publications are in force, was noted. The Chairman reported that the Rubber Growers' Association had yet to state their requirements, but that their bulletins would be circulated through the Secretary only to the members of the Board. Consideration of a Scheme of local circulation of the Scheme's publications was deferred.

(b) A letter from the Malayan Fertilisers Ltd., asking for permission to reprint Mr. Taylor's booklet "Replanting and Rejuvenation of old Rubber" was left to be dealt with at the discretion of the Chairman.

(c) A reprint of Mr. Lord's report on a visit to Malaya, Indo-China, Sumatra and Java, which had appeared in *The Tropical Agriculturist* for October 1929, at a cost of Rs. 125 for 750 copies, was sanctioned.

By order,
J. I. GNANAMUTTU,
Secretary,
Board of Management.

RUBBER RESEARCH SCHEME (CEYLON)

EXTRAORDINARY GENERAL MEETING

An Extraordinary General Meeting of the members of the Rubber Research Scheme (Ceylon), subscribers to its funds up to July 31, 1930, was held in the ball-room of the Grand Oriental Hotel, Colombo, at 11 a.m. on Thursday, March 26, 1931.

Present :—The Hon. Dr. W. Youngman, (in the chair), Messrs. C. W. Bickmore, Assistant Colonial Treasurer, C. L. Carson-Parker, representing Messrs. Bois Bros. & Co., J. A. D. Finch Noyes, representing Messrs. George Steuart & Co., F. F. Roe, representing Messrs. Gordon Frazer & Co., Ltd., Mr. J. S. McIntyre, representing Messrs. Leechman & Co., Mr. G. R. Whitby, representing Messrs. Bosanquet & Skrine, Ltd., Mr. Wilmot A. Perera, representing the Hegalla Tea & Rubber Estates Ltd., Mr. H. R. Freeman and Mr. A. E. de Silva, members of the present Board of Management, Mr. T. E. H. O'Brien, Chemist & Chief Technical Officer, and Mr. R. K. S. Murray, Mycologist, Mr. J. I. Gnanamuttu (Secretary).

In opening the proceedings, the Chairman drew the attention of the meeting to the accounts. There was a balance sheet and an income and expenditure account as at July 31, and a further set of accounts as at December 31. The former up to the date the new Board of Management was constituted under Ordinance No. 10 of 1930 and had been audited by Messrs. Duncum, Watkins, Ford & Co. The latter had been audited and certified by the Colonial Auditor. In the period August to December, the Board of Management had been carrying on the old Rubber Research Scheme from the balance of its funds which were now exhausted. These accounts complete the transactions of the whole of 1930. The Chairman asked the sanction of the meeting to pay Messrs. Duncum, Watkins, Ford & Co. the fee of Rs. 500 which had been voted for 1930. This payment was passed unanimously. The accounts as published were accepted.

The Chairman stated that following the main report of the Scheme for 1930, were the reports of the technical officers of the Scheme. Messrs. O'Brien and Murray would supply any information that might be desired in relation to those reports. The reports of the Chemist, the Physiological Botanist, and the Mycologist were accepted without comments.

The report of the London Advisory Committee was then passed without comments.

The Chairman then submitted that at the final meeting of the Executive Committee of the erstwhile Rubber Research Scheme, which was held on October 24, 1930, it had been unanimously resolved:

> "That the entire assets, liabilities and staff of the old Rubber Research Scheme be offered to the Board of Management of the new Rubber Research Scheme, with effect from August 1, 1930, the date on which the Rubber Research Ordinance came into operation."

He moved that the meeting should confirm this decision on behalf of the subscribers. The resolution was assented to unanimously.

The Chairman then moved that the meeting should record the assent of the subscribers to the assignment of the lease of the land at Nivitigalakele entered into by the Crown with the erstwhile Rubber Research Scheme (Ceylon), to the Board of Management of the Rubber Research Scheme as constituted under Ordinance No. 10 of 1930. This was carried unanimously. The transference of the leases of land held at Culloden from the Rosehaugh (Ceylon) Rubber Co. Ltd., to the Board of Management of the new Scheme was also unanimously agreed to.

The Chairman concluded by stating that was all the business he had to put before the meeting which marked the passing of the old Rubber Research Scheme and the institution of the new Scheme constituted under Ordinance No. 10 of 1930. A résumé of the publications issued by the staff under the old Scheme was attached to the report, and it shewed that some 41 Quarterly and Special Circulars and 50 Bulletins had been issued. He had no doubt but that those publications had been of some use, and he hoped that the activities of the new Board would be of further use and do something to help, if possible, to put the rubber industry of Ceylon on its feet again.

The Chairman invited remarks from those present. Mr. Roe asked a question about the continuation of the research work in London. The Chairman replied that the new Board of Management had resolved to continue the London organization in 1931 and had under consideration a proposal to amalgamate the work in London for both Ceylon and Malaya.

J. I. GNANAMUTTU,
Secretary,
Board of Management,
Rubber Research Scheme.

TEA RESEARCH INSTITUTE

MINUTES OF LAST BOARD MEETING

HELP FOR SMALL-HOLDERS ESSENTIAL
SUB-COMMITTEE APPOINTED

A meeting of the Board of the Tea Research Institute of Ceylon, was held in the Victoria Commemoration Buildings, Kandy, in April.

Those present were: Mr. R. G. Coombe (Chariman), the Colonial Treasurer, the Director of Agriculture, Messrs. A. G. Baynham. J. W. Oldfield, John Horsfall, Jas. Forbes (Jnr.), R. R. Muras (Assistant Secretary), A. W. L. Turner (Secretary), and by invitation Dr. Roland V. Norris (Director, T.R.I.).

The Chairman announced that Mr. G. K. Stewart had been elected Chairman of the Ceylon Estates Proprietary Association, and automatically succeeded Mr. F. F. Roe on the Board.

He proposed that a cordial vote of appreciation be passed to Mr. F. F. Roe for his services on the Board. This was carried.

FINANCE

Second Conference of the T.R.I.—An additional vote of Rs. 500 was sanctioned to cover the expenditure incurred in connexion with the Conference of the T.R.I. held at St. Coombs in February last.

Finance Sub-Committee.—The Chairman remarked that this Sub-Committee had met that morning and all the members of the Board would receive minutes of that meeting in due course.

Bungalows.—The Chairman said that the last building programme which was drawn up allowed for one senior staff bungalow in 1932 and one in 1933. Certain difficulties had arisen in connection with the housing of the senior staff.

It was decided that should funds permit the programme should be advanced in six months.

ST. COOMBS ESTATE

Visiting Agent.—The Chairman announced that Mr. J. W. Ferguson had returned from leave and relieved Mr. J. E. B. Baillie-Hamilton, who was acting for him as Visiting Agent of St. Coombs.

Mr. John Horsfall proposed that a vote of thanks be recorded to the Acting Visiting Agent, Mr. Baillie-Hamilton. This was carried.

SECOND CONFERENCE OF THE T.R.I.

The Chairman announced that the Second Conference of the T.R.I. was held on the 26th and 27th February, the laboratories being opened by His Excellency the Officer Administering the Government. A full report would be published in *The Tea Quarterly.*

Major Oldfield proposed that a vote of thanks to Dr. Norris be recorded for the extremely able way in which the Conference was conducted. This was agreed to.

The Chairman said that he would like to associate himself with Major Oldfield's remarks.

THE PERSIAN TEA INSTITUTE

The consideration of an application of a request by the Persian Tea Institute for one of its representatives to be instructed in all branches of tea planted was postponed pending settlement of an outstanding account for tea seed purchased in October, 1929.

SMALL-HOLDERS

The Chairman said that Mr. Panabokke was not able to be present that day and had asked that his resolution be postponed.

The Chairman added that his was not a new question and he thought that they should appoint a small Sub-Committee. It was very essential that they should do something to help the small-holders. He therefore proposed that a Sub-Committee be appointed to go into the ways and means to help the small-holders and that they should ask Mr. Panabokke to propose his resolution at the next meeting.

The Board decided to appoint the following Sub-Committee:—

Messrs. D. S. Senanayake, T. B. Panabokke, the Director, T.R.I., and the Director of Agriculture.

PESTS AND DISEASES

Termites.—The Chairman stated that a circular, dated the 17th March, in connexion with Dr. Snyder's visit to Ceylon as well as the views of the various members of the Board thereon had been sent to each member of the Board.

It was decided that the Board write to Government and inform them that the Institute would be prepared to pay some proportion of the expenses.

EXPERIMENTAL AND ESTATE SUB-COMMITTEE

The Chairman's action in having invited Mr. Jas. Forbes (Jnr.) to fill the vacancy created by the resignation of Mr. Huntley-Wilkinson as from the 1st March, 1931, was confirmed by the Board.

The Chairman said that this Sub-Committee had held a meeting at St. Coombs the previous day in connexion with pruning. Another meeting had been held that morning at the Experimental Station, Peradeniya, and it had been tentatively suggested that certain experiments in pruning should be carried out simultaneously at St. Coombs and Peradeniya. He considered that those interested should know that these experiments were to be carried out and that they could come and see them. In the course of time they hoped to shew villagers how pruning should be carried out. He suggested that the Director should be asked to make a statement at a General Committee Meeting of the P. A. and also address the next Estate Products meeting on the subject.

PUBLICATIONS

The Director stated that a suggestion arose in regard to the publication of experimental result. At present the Institute's publications consisted of Bulletins and *The Tea Quarterly* and he thought that work which was in progress should be published in *The Tea Quarterly* and the Bulletins utilised for the publication of completed pieces of work. In the above publications the papers would not be in their technical form and officers naturally wished to publish their full technical results, but it would be agreed that if these were published in a very technical way in the Institute's publications and circulated to all planters and subscribers no very useful purpose would be served. He therefore thought that the best solution was that officers should be allowed to contribute to outside journals, but, of course, all such results would first be published in a popular form in the Institute's publications.

The Board agreed to these proposals.

Factory Handbook.—The Director mentioned that they had received a considerable number of enquiries about the Handbook of Factory Information. It required amplification and for that reason it had not yet been published in Bulletin form. It was his intention to amplify the book and publish it later—probably by the end of the year, when it would be sent to all subscribers to *The Tea Quarterly.*

The Board agreed to this course.

DEPARTMENTAL NOTES

PROGRESS REPORT OF THE EXPERIMENT STATION, PERADENIYA

FOR THE MONTHS OF MARCH AND APRIL, 1931

TEA

THE decision to cease experimentation in tea has been provisionally reversed, and the duplication of a pruning experiment, or part of experiment, to be carried out by the Tea Research Institute at St. Coombs is now under discussion.

The tea in general suffered more severely from the drought that has been observed for a number of years. Though exact comparison is not possible owing to differentiation of treatment, it may be stated that the tea which survived the drought best was that under *Albizzia* or *Glircidia* with or without a cover crop, next tea under dadaps with *Indigofera endecaphylla*, next tea with *Indigofera* but no shade trees, next tea under dadaps but no cover crop, and lastly tea with no shade trees and no cover crop.

Supplies suffered severely and 46% of the plants put in 1930 were lost. Tentative conclusions as to the survival of supplies under different conditions drawn in the progress report for July and August, 1930, cannot be maintained

The usual manures were applied to the plots under the *Indigofera* trial in the usual manner in April. This will be the last application of these manures, as this trial, in its present form, is due to terminate at the end of September, 1931. Future manurial treatment will depend partly on the plans for a pruning experiment. All plots not included in the *Indigofera* trial were forked in alternate rows in the latter half of April. Alternate shade trees were lopped before this forking and all loppings were forked in. In plots where *Indigofera endecaphylla* was growing, as much of the creeper as possible was forked in, but without cutting the creeper it was found difficult to incorporate much of the green material. Two furrow forks supplied by Messrs. Harrisons and Crosfield were tried during these forking operations. These forks, which are fitted with a flat strip of metal across the prongs, certainly tend to prevent earth passing through the prongs during the pushing forward motion of envelope-forking and thus leave a clearer open "envelope" for the insertion of green material, etc.

RUBBER

The Hilltop Rubber

The experiments in this area terminated at the end of December, 1930. The final results are given below.

The Hilltop Rubber (which was planted in 1913) is divided into three blocks, A, B, and C.

Block A is planted with clumps of 4 trees 12 feet by 15 feet, with 40 feet between the clumps, giving 69 trees per acre.

Block B is planted in avenues 12 feet by 15 feet, with 40 feet between the avenues, giving 112 trees per acre.

Block C is planted 20 feet by 20 feet, giving 109 trees per acre.

Half the trees in blocks A and B are tapped with a V cut and half with a single cut, while in block C half the trees are tapped on alternate days and half every third day. To compare the three methods of planting, therefore, it is only possible to take into consideration those trees which are tapped on alternate days with a single cut, i. e., half the number of trees in each block. Tapping was started on April 1st, 1922, but thereafter yields were recorded from January to December so that the first period is one of nine months only. The yields are given in the following table:

Block and method of planting	No. of trees per acre	Average yield per tree 1930		Average yield per tree Previous		Average yield per tree Total		Calculated yield per acre 1930	Calculated yield per acre Previous	Calculated yield per acre Total
		lb.	oz.	lb.	oz.	lb.	oz.	lb.	lb.	lb.
A Clumps of 4 trees 12 ft. by 15 ft. with 40 ft. between clumps	69	7	5	33	1	40	6	505	2430	2935
B Avenues. Trees 12 ft. by 15 ft. with 40 ft. between avenues	112	3	6	21	7	24	13	378	2377	2755
C Square planting 20 ft. by 20 ft.	109	4	3	25	3	29	6	456	2731	3187

The relative positions of the blocks as regards yield per tree has been the same throughout the experiment. The superiority of yield per tree in block A has progressively increased until in 1926 the calculated yield per acre of the block was within 1 lb. of that of block B which has 112 trees per acre. In 1927 and succeeding years the yield per acre in block A has exceeded that in block B but has never reached that of block C.

In growth, as shown by girth measurements, block A has shown the same superiority.

	Average girth December 1921 Inches	Average girth December 1930 Inches	Average increase Inches
Block A ..	28.5	54.8	26.3
Block B ...	29.5	43.9	14.4
Block C ...	27.5	43.0	15.5

The superiority in the development of side branches and in foliage of the trees in block A on the outside of the clumps is very marked. One side of this block adjoins a tea field and thus has the advantage of further additional light and air. On the other hand this side is also very exposed to wind and one would have expected this to have a detrimental effect on early growth.

The superiority of outside trees in branch development, foliage and yield is a matter of common observation and in the case of block A it would certainly appear that by giving two sides of each tree a clear space the yield per tree had been increased to such an extent as finally to more than compensate for the reduced number of trees per acre. Such a method of planting in widely spaced clumps would have the further advantage that the cultivation of a catch crop would be facilitated and conld be continued considerably later than with ordinary planting. Alternatively, on flat land, cultivation by implements could be continued later. On the other hand there is the grave disadvantage that if a case of root disease occurs it is most probable that all four trees of the clump would be affected since their roots are intermingled and isolation is difficult or impossible.

The reason for the comparative inferiority of block B is hard to find. The trees are growing on almost flat land well sheltered on every side. Block C, on the other land, is steep and rocky but the trees have always yielded better than those of block B. One is rather led to infer from the yields of these blocks that light and air are more important factors than protection from wind.

As has been mentioned half the trees in blocks A and B were tapped with a V-cut and half with a single left-to-right cut. In both cases the cuts occupy half the circumference and are at the same height from the ground. The average yields per tree from the start of the experiment are given below :

Year	Single cut Block A	Single cut Block B	Single cut Average	V cut Block A	V cut Block B	V cut Average	Average increase per tree from use of V cut
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
1922	2 7	1 12	2 1	2 5	1 12	2 0	– 1
1923	3 11	2 4	3 0	4 0	2 12	3 6	+ 6
1924	4 14	2 13	3 13	5 10	3 7	4 9	+ 12
1925	5 0	3 2	4 1	5 7	3 10	4 9	+ 8
1926	4 8	3 0	3 12	5 3	3 0	4 1	+ 5
1927	5 0	2 14	3 15	5 6	3 9	4 8	+ 9
1928	4 7	2 10	3 8	4 15	3 6	4 2	+ 10
1929	5 11	3 0	4 6	6 11	4 3	5 7	+1 1
1930	7 5	3 6	5 6	7 15	5 2	6 8	+1 2
Total	42 15	24 13	33 13	47 8	30 13	39 2	+5 5

After the first period there has been a substantial, and apparently increasing, gain in favour of the V cut, amounting, over the whole period, to 5 lb. 5 oz. per tree.

One of the advantages claimed for the V cut is a reduction in the proportion of scrap to total crop. The percentage of scrap obtained by these two methods of tapping is shown below :

Year	Percentage scrap of total crop Single cut	V cut
1922	11·0	11·6
1923	10·7	13·9
1924	16·8	14·4
1925	17·7	10·0
1926	23·3	19·0
1927	17·1	17·9
1928	18·0	20·5
1929	21·4	15·8
1930	19·1	14·5
Average	17·2	15·3

Over the whole period there is a slight gain in favour of the V cut but this has not been consistent and is possibly fortuitous.

In block C a comparison between alternate day tapping and three-day tapping has been in progress. The cuts on the trees tapped every three days were started at two-thirds the height of the cuts on the trees tapped on alternate days so that the two cuts have reached the bottom of the trees at the same time. The following table shows the average yields per tree :

	Alternate day tapping				Three-day tapping				Percentage of alternate day tapping yields obtained by three day tapping
	Series 1	Series 3	Series 5	Average	Series 2	Series 4	Series 6	Average	
Year	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	%
*1922	2 2	2 3	1 13	2 1	1 10	1 9	1 9	1 9	75·5
1923	3 0	3 2	2 10	2 15	2 10	2 4	2 8	2 7	85·1
1924	3 6	4 1	3 5	3 9	2 12	2 13	2 13	2 13	79·0
1925	3 6	3 12	3 13	3 11	2 15	2 15	2 15	2 15	81·4
1926	3 3	3 4	3 1	3 3	2 14	2 12	2 11	2 12	80·9
1927	3 5	2 15	3 8	3 4	2 6	2 8	2 7	2 7	82·5
1928	3 1	3 0	2 13	2 15	2 2	1 15	2 2	2 1	74·6
1929	3 11	3 14	3 11	3 12	3 5	2 13	2 11	2 15	78·3
1930	4 12	4 0	4 0	4 4	3 13	3 4	3 0	3 6	79·4
Total	29 14	30 3	28 10	29 10	24 7	22 13	22 12	23 5	79·6

* April to December only.

It would appear that a reduction of the number of tappings by one-third has only reduced the yield by about one-fifth. The cost of production would not of course be reduced by one-third but it appears probable that the cost of production of the rubber obtained from the trees tapped every third day would be less than the cost of the rubber obtained by alternate day tapping.

A possibly more potent argument in favour of three-day tapping is the undoubted reduction in brown bast incidence. At the end of 1930, out of 168 trees tapped by each method, 45 or 26.8 %, had been treated for brown bast or showed symptoms of the disease among the trees tapped on alternate days against 12 trees, or 7.1 %, of the trees tapped every three days. This difference has been consistently shown throughout the experiment and confirms a similar result found in a previous two-versus-three-day tapping experiment. A considerable number of fresh brown bast cases were noted in 1930.

The Hillside Rubber

In this area an experiment has been carried on since April 1st, 1922 to compare the yields and disease incidence from tapping on alternate days throughout the year and tapping daily in alternate months. To obviate differences caused by unequal weather conditions in the different months, two series were tapped daily in the months of January, March, May, etc., two in the months of February, April, June, etc., while the remaining two series were tapped throughout the year on alternate days.

The average yields per tree from the start of the experiment are given below.

	Alternate daily throughout the year			Daily in January, March, May, etc.			Daily in February, April, June, etc.			
	Series 1	Series 6	Average	Series 2	Series 4	Average	Series 3	Series 5	Average	Average of all daily tapped blocks
Year	lb oz.	lb. oz.	lb, oz.	lb. oz,	lb. oz.	lb. oz.	lb. oz.	lb, oz.	lb. oz.	lb. oz.
*1922	1 14	1 14	1 14	1 13	2 0	1 14	1 15	1 15	1 15	1 15
1923	3 8	3 0	3 4	3 0	3 3	3 2	2 14	3 0	2 15	3 0
1924	4 1	3 11	3 14	3 9	3 8	3 8	3 14	3 14	3 14	3 11
1925	3 13	3 4	3 9	3 10	3 9	3 9	3 12	3 15	3 14	3 11
1926	3 10	3 5	3 8	3 11	3 9	3 10	4 5	3 8	3 15	3 13
1927	4 4	4 12	4 8	3 5	3 12	3 8	3 14	4 0	3 15	3 12
1928	4 2	4 2	4 2	2 15	3 6	3 3	3 4	3 9	3 6	3 4
1929	4 10	4 7	4 8	3 12	4 8	4 3	4 3	4 6	4 4	4 4
1930	5 10	5 7	5 8	4 5	5 5	4 13	5 10	5 2	5 6	5 2
Total	35 8	33 14	34 11	30 0	32 12	31 6	33 11	33 5	33 8	32 8

* April to December only.

Over the whole period of 8 years and 9 months the average yield per tree shows a superiority of 2 lb. 3 oz. in the plots tapped on alternate days' It is found that after resting for a month, the trees which are tapped daily in alternate months usually take seven to ten days before attaining their maximum flow of latex and in view of this it is perhaps surprising that the yields of the daily tapped series come as close to the yields of the series tapped on alternate days as they do. From the results of this experiment one would say that there appears to be no advantage as regards yield to be gained by adopting monthly periodic tapping in place of the customary alternate day tapping, though it might. be considered more convenient to have all the tapping labour concentrated in one portion of the estate during any one month.

In the matter of brown bast incidence there appears to be a decided disadvantage in tapping daily in alternate months. At the end of 1930, 22·9% of the trees tapped daily in alternate months had been treated for or showed symptoms of brown bast against 10·9% of those tapped on alternate days. Although the difference in brown bast incidence between alternate day tapping and tapping daily in alternate months has never been as striking as between alternate day tapping and three-day tapping, yet throughout the course of the experiment the trees tapped daily in alternate months have always shown a considerably higher incidence, and for this reason, if for no other, it does not appear possible to recommend the system.

The Change-over Experiment

In the last report bark renewal figures for this experiment were given, and at the last meeting of the Estate Products Committee a question was asked as to the incidence of brown bast in this experiment. These figures are given below, but it would be difficult to draw from them any definite conclusion as to the effect of changing over the cut on the incidence of brown bast.

Incidence of Brown Bast in Change-over Experiment at end of 1930

No change-over		Change-over once yearly		Change-over twice yearly	
Plot	No. of cases	Plot	No. of cases	Plot	No. of cases
(1)	1	(1)	2	(1)	nil
(2)	nil	(2)	1	(2)	nil
(3)	1	(3)	3	(3)	nil
(4)	nil	(4)	nil	(4)	1
(5)	1	(5)	1	(5)	3
(6)	2	(6)	4	(6)	nil
(7)	nil	(7)	1	(7)	3
(8)	nil	(8)	1	(8)	1
	5 = 3·9%		13 = 10%		8 = 6·2%

CACAO

The pruning programme outlined in the January-February report has made fair progress. All the ordinary pruning has been completed and about half the Hillside Block, where a gradual removal of the old stems and rejuvenation from suckers is in progress, has been dealt with. This is very heavy and slow work and can only be done with a cross cut saw. The cutting up of the felled stems has not yet been attempted. No labour has yet been available to start the pollarding in the centre block.

The manurial experiment was brought to a conclusion at the end of March, and the results were incorporated in an article submitted in April for publication in *The Tropical Agriculturist.*

The yields of dry cacao per acre for the last 8 years have been as follows:

Year		Cwt. dry cacao per acre		Rainfall
1923-24	...	2·24	...	106·42
1924-25	...	3·10	...	103·82
1925-26	...	5·45	...	87·31
1926-27	...	5·03	...	98·11
1927-28	...	4·41	...	80·33
1928-29	...	2·49	...	88·95
1929-30	...	4·58	..	98·71
1930-31	...	3·15	...	89·75

The percentages of good and black cacao during the last four years have been as follows:

Year	Good	Black	Rainfall
1927-28	82·9	17·1	80·33
1928-29	73·4	26·6	88·95
1929-30	83·2	16·8	98·71
1930-31	69·5	30·5	89·75

The percentage of black cacao is more influenced by the seasonal incidence of the rainfall than by the total fall. Very heavy rain fell in October and November 1930—19·02 and 10·98 inches respectively.

COFFEE

Half the shade trees (*Gliricidia maculata*) were uprooted in plots 140 N, 140 J, and 140 K. Further thinning of coffee shade is required in the six-acre coffee field and elsewhere, and this will be done as soon as labour can be spared.

The last of the Hybrid coffee bushes in plot 140 H (round the show plots) were uprooted during April.

Recent prices for coffee have been exceedingly low. Two auction sales were abandoned owing to lack of bidders and coffee sent to Colombo for sale fetched the equivalent of the following prices per pound:

Robusta	varieties,	parchment	12 cts. per lb.
,,	,,	sundried	3½ ,, ,,
Liberian	,,	,,	1¾ ,, ,,

FODDER PLANTS

A further area of the Panchikawatte paddy fields was drained and planted in April with Guinea grass. About half this area is now planted in different fodder grasses.

GREEN MANURES AND COVER PLANTS

The *Centrosema pubescens* in the young budded rubber in plot 174 had got badly overgrown with couch, illuk, sensitive plant, and other weed growth. The whole cover was uprooted in March and strips were ploughed between the young trees and *Centrosema* sown again in April.

The green manure experiments which have been carried on in collaboration with the Agricultural Chemist in plots 16-20 and in the Annual Economic Area were brought to a conclusion with the taking of the last annual soil samples in April. Results will be published in due course by the Agricultural Chemist.

OIL YIELDING PLANTS

In the terraced valley an additional 33 plants of *Taraktogenos kurzii* (Chaulmoogra oil), and an additional 56 plants of *Aleurites montana* (tung oil) were planted out in April. Further plants of *Aleurites montana* are coming on in pots and a further area is being terraced and prepared for their reception.

During March a great deal of Croton oil seed was shed from the trees in the economic collection. Nearly all this seed was empty and useless. An examination of the seed by the Mycologist and by the Entomologist revealed no disease or pest, and the trouble must be presumed to be physiological and probably dne to drought conditions.

An enquiry addressed to the Imperial Institute as to whether any new uses have been found for Croton oil produced the reply given below :

Imperial Institute,
South Kensington,
London, S. W. 7.
April 1, 1931.

Ref. No. 681/2.

Sir,

"In reply to your letter (A. 2615) of the 23rd February, I have to send you the following information :

"Croton Tiglium oil is principally used in medicine, as a very powerful purgative. It appears to be customary for firms in this country to prepare the oil themselves from imported seed. Very little, if any, croton oil is

imported here. There is a more or less regular demand for the seed in the United Kingdom. Latterly there has been a severe shortage, and for the past six months the value of the seed in London has been between about 230s. and 290s. per cwt., that of the oil being about 14s. to 15s. per lb. The 'normal' values of the seed and of the oil are about 30s. to 40s. per cwt and 3s. 9d. per lb. respectively.

"Recent quotations were 280s. per cwt. for the seed, and 13s. 4½d. per lb. for the oil, and according to firms that have been consulted by the Imperial Institute there are indications that conditions in the market are becoming easier."

THE IRIYAGAMA DIVISION

The clearing of a new area to contain three more foreign clones, with H2 as control, is in progress.

It will not be possible to import stumps of any more promising foreign clones for the present owing to lack of funds. The original estimates contained no provision for such importations.

Below area 2, 312 1928 seedling trees which are not included in any area remain standing. These trees are being utilised as follows: 42 trees for a small experiment to be known as the influence of scion on seedling stock experiment. These trees have been divided into two groups, in randomised pairs. One group is to be budded with B.D 5 at 3 feet from the ground; the other group will not be budded. The idea is to tap both groups above 3 feet and below three feet and note any effect produced on the yields of the stock by the addition of a scion of a proved high-yielding clone.

The remainder of the trees are to be used for an experiment to be called influence of scion on budded stock experiment. All these trees have been budded low down with AVROS 49 and when these bud shoots are sufficiently large and mature, half the trees will be budded high up with buds from a proved high-yielding clone and half with buds from a known low-yielding tree. The trees will then be tapped to determine whether the trees bearing crowns of a high-yielding clone yield better than those bearing crowns of a low-yielding clone. The experiment is considered to be likely to yield more valuable results than the influence of scion on seedling stock experiment, since in that experiment the yields of the seedling stocks (although they are all grown from seed of one tree) are likely to show more variation than the yields of the budded stocks in the influence of scion on budded stock experiment.

GENERAL

With the advent of the rains the shortage of labour resulting from reduced funds, aided by the annual dislocation caused by the Sinhalese New Year, has been severely felt. It has not yet been possible to start the annual cleaning of drains, and women and children have had to be put on for the very urgent work of eradicating couch and illuk. The work of course has not been so efficiently performed and is not likely to prove very satisfactory.

T. H. HOLLAND,
Manager,
Experiment Station, Peradeniya.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st MAY, 1931

Province, &c.	Disease	No. of Cases up to Date since Jan. 1st 1931	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	328	88	54	239	19	16
	Foot-and-mouth disease	665	195	615	15	35	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	2*	...	...	...	...	2
	Piroplasmosis	...	...	...	...	...	...
Colombo Municipality	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	215	4	199	8	8	...
	Anthrax (Sheep & Goats)	11 †	..	...	11	...	...
	Rabies (Dogs)	3	1	...	...	...	3
	Haemorrhagic Septicaemia	...	...	...	...	...	...
	Black Quarter	...	...	...	...	...	...
	Bovine Tuberculosis	...	...	...	...	...	...
Cattle Quarantine Station	Rinderpest	.	...	...	...	...	...
	Foot-and-mouth disease	28	28	...	...	28	...
	Anthrax (Sheep & Goats)	97	9	...	97	...	...
Central	Rinderpest	...	..	..	..	...	...
	Foot-and-mouth disease	149	135	50	...	89	...
	Anthrax	...	...	..	...	...	..
	Rabies (Dogs)	7	1	...	..	...	7
Southern	Rinderpest	...	..	...	...	...	...
	Foot-and-mouth disease	1346	307	1216	5	125	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...	...	..	...	...	...
Northern	Rinderpest	FREE					
	Foot-and-mouth disease						
	Anthrax						
	Black Quarter						
	Rabies (Dogs)						
Eastern	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	...	...	...		...	...
	Anthrax	...	...	...	...	...	...
	Surra	5	...	...	5	...	..
North-Western	Rinderpest	8972	2435	100	8042	55	775
	Foot-and-mouth disease	44	44	...	...	44	...
	Anthrax	...	...	...	..	...	...
	Pleuro-Pneumonia (in Goats)	...	...	...	...	...	...
North-Central	Rinderpest	3335	914	449	2677	114	95
	Foot-and-mouth disease	...	...	...	...	...	...
	Anthrax	...	...	...	...	...	...
Uva	Rinderpest	...	...	...	...	...	...
	Foot-and-mouth disease	5	4	1	...	4	...
	Anthrax	...	...	...	...	...	...
	Rabies (Dogs)	...		...	...	...	...
Sabaragamuwa	Rinderpest	...	...	..	...	...	...
	Foot-and-mouth disease	68	27	45	...	23	...
	Anthrax	..	...	...	...	...	...
	Haemorrhagic Septicaemia	24	6	...	24	...	...
	Piroplasmosis	2	1	1	...	1	...
	Rabies (Dogs)	3	2	...	...	...	3

* 1 case in a cow. † 2 cases amongst cattle.

G. V. S. Office,
Colombo, 10th June, 1931.

G. W. STURGESS,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT

MAY, 1931

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Inches		Inches
Colombo	87·3	+0·3	77·2	+0·3	79	91	8·4	11·81	27	− 2·39
Puttalam	89·0	+1·2	78·6	+1·0	75	87	6·6	1·33	12	− 2·30
Mannar	90·4	−0·1	81·3	+1·1	74	81	4·5	0·84	2	− 1·27
Jaffna	88·2	+0·6	82·8	+1·3	77	79	4·6	1·38	2	− 0·44
Trincomalee	91·3	−0·8	78·3	+0·3	—	—	—	3·18	6	+ 0·47
Batticaloa	89·5	−0·7	77·3	+0·8	76	93	6·8	1·48	6	− 0·37
Hambantota	87·8	+1·2	77·9	+1·9	77	89	5·4	1·87	10	− 1·45
Galle	85·0	+0·1	78·1	−0·1	85	91	7·4	12·41	22	+ 0·92
Ratnapura	88·8	+0·9	75·1	0	78	93	5·6	18·47	22	+ 0·06
A'pura	90·3	−0·3	76·2	+0·1	71	88	8·4	5·05	7	+ 1·62
Kurunegala	89·3	0·3	76·2	+0·5	72	88	7·6	5·65	12	− 1·09
Kandy	87·1	+1·6	70·9	+0·1	72	90	6·6	3·37	14	− 2·45
Badulla	85·7	+0·4	66·8	+1·2	73	95	5·3	3·14	10	− 1·59
Diyatalawa	80·6	+2·6	63·1	+1·5	67	84	6·0	3·13	8	− 2·25
Hakgala	75·2	+1·7	58·8	+1·9	72	89	5·1	2·23	13	− 5·00
N'Eliya	72·0	+1·3	53·3	+1·6	76	94	7·2	4·16	13	− 2·86

The rainfall of May was distinctly below average, deficits being most marked in the upper part of the Kelani Valley and the Ambegamuwa and Pussellawa districts. The chief areas in which the average was passed were the western half of the S.P., and a few stations in central Sabaragamuwa and the northern part of the W.P. Averages were also exceeded at most of the stations in the N.C.P. and at a few in each of the N.P., N.W.P., and E.P., though in these cases the excess did not depend so much on very heavy rain as on the lowness of the averages for May.

In the first half of the month such rain as occurred was largely of the thunderstorm type. There were several noteworthy falls on the 3rd, chiefly near the west coast, including Angoda 9·69 and Horakelle 7·72, and also on the 7th when Eheliyagoda reported 9·05, and 9th including Kokkawita 7·45. Squally weather was also noteworthy in the Batticaloa district on the 10th and 11th. From the 15th to the 22nd there was comparatively little rain but from the 23rd to the end of the month there was pretty general rain over the south-west quarter, but comparatively few very heavy falls, though Mawarella and Morawake each recorded about 7 inches on the 25th.

The highest totals were at Carney 29·09 (which is however below the average at the station) and Eheliyagoda 28·60.

The total wind movement was above average in the north, and below it in the south. On the west coast there was less monsoonal activity than usual during the greater part of the month but some vigorous squalls from the 26th onwards, including a velocity of over 50 miles per hour at the Pilot Station on the 29th.

The duration of sunshine was a trifle below normal, although it will be seen that temperatures were on the whole slightly above average.

A. J. BAMFORD,

Superintendent, Observatory.